

*Stormwater Report*  
*“The Village At Institute Road”*  
*Grafton, MA*

*Date: September 13, 2016*  
*Revised February 2, 2017*



Prepared For:  
*D&F Afonso Builder Corp.*  
*189 Main Street*  
*Milford, Ma 01757*

Prepared By:  
*Guerriere & Halnon, Inc.*  
*333 West street*  
*Milford, MA 01757*  
*G&H Project G-9411*

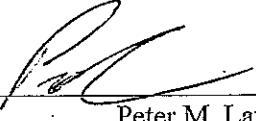
Narrative:

The project proponent proposes to construct a 46 lot residential development. This development is known as "The Village At Institute Road" and consists of 46 single family homes serviced by public water and sewer and driveway as shown conceptual on the Definitive Plans. The development also includes construction of three 26' wide paved roadways as shown on the plans. The proposed drainage system will consist of catch basins and drain manholes along the proposed roadways and directed to a forebay and infiltration basin.

The itemized report that follows will document design compliance with the Massachusetts Stormwater Management Standards 1-10.

---

Date



Peter M. Lavoie

## *Stormwater Report*

A Stormwater Report must be submitted with the permit application to document compliance with the Stormwater Management Standards. The Stormwater Report must be organized into sections that correspond to the categories listed in the Checklist (e.g., Project Type, LID Practices, Standard 1 etc.). As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Stormwater Report must be prepared by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8<sup>1</sup>
- Operation and Maintenance Plan required by Standard 9
- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (attached) that certifies that the Stormwater Report contains all required submittals.<sup>2</sup>

In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans are required to show existing and proposed conditions, identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), and any areas on the site where infiltration rate is greater than 2.4 inches per hour. The Plans shall identify the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations.

As noted in the Checklist, the Stormwater Management Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook.

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has

---

<sup>1</sup> For some complex projects, it may not be possible to include the Construction Period Erosion and Sedimentation Control Plan in the Stormwater Report. In that event, the issuing authority has the discretion to issue an Order of Conditions that approves the project and includes a condition requiring the proponent to submit the Construction Period Erosion and Sedimentation Control Plan before commencing any land disturbance activity on the site.

<sup>2</sup> The Stormwater Report may also include the Illicit Discharge Compliance Statement required by Standard 10. If not included in the Stormwater Report, the Illicit Discharge Compliance Statement must be submitted prior to the discharge of stormwater runoff to the post-construction best management practices.

## *Massachusetts Stormwater Report Checklist*

not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification must be submitted with the Stormwater Report.

### **Stormwater Checklist and Certification**

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary to comprise a comprehensive Stormwater Report that addresses the ten Stormwater Standards. *Note:* Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

#### **Registered Professional Engineer's Certification**

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.



Registered Professional Engineer Block and Signature

Signature, Date

Elizabeth A. Mainini  
2/7/17

## *Massachusetts Stormwater Report Checklist*

**Project Type:** Is the application for new development, redevelopment, or a mix of new and redevelopment?

- X New Development
- Redevelopment
- Mix of New Development and Redevelopment

**LID Measures:** Stormwater Standards require LID measures to be considered. Document what environmentally sensitive design and LID Techniques were considered during the planning and design of the project:

- X No disturbance to any Wetland Resource Areas
- Site Design Practices (e.g. clustered development, reduced frontage setbacks)
- Reduced Impervious Area (Redevelopment Only)
- Minimizing disturbance to existing trees and shrubs
- LID Site Design Credit Requested:
  - Credit 1
  - Credit 2
  - Credit 3
- X Use of “country drainage” versus curb and gutter conveyance and pipe
- Bioretention Cells (includes Rain Gardens)
- Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
- Treebox Filter
- Water Quality Swale
- Grass Channel
- Green Roof
- X Other Roof recharge

### **Standard 1: No New Untreated Discharges**

- X No new untreated discharges
- X Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
- X Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

### **Standard 2: Peak Rate Attenuation**

- Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.
- X Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm
- X Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

## *Massachusetts Stormwater Report Checklist*

### **Standard 3: Recharge**

- X Soil Analysis provided.
- X Required Recharge Volume calculation provided
- Required Recharge volume reduced through use of the LID site Design Credits.
- Sizing the infiltration BMPs is based on the following method: Circle the method used.

Static	Simple Dynamic	Dynamic Field <sup>3</sup>
--------	----------------	----------------------------
- X Runoff from all impervious areas at the site discharging to the infiltration BMP.
- Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.
- X Recharge BMPs have been sized to infiltrate the Required Recharge Volume.
- Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:
  - Site is comprised solely of C and D soils and/or bedrock at the land surface
  - M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
  - Solid Waste Landfill pursuant to 310 CMR 19.000
  - Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.
- X Calculations showing that the infiltration BMPs will drain in 72 hours are provided.
- Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.
- The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and, a mounding analysis is provided.
- X Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

### **Standard 4: Water Quality**

The Long-Term Pollution Prevention Plan typically includes the following:

- Good housekeeping practices;
- Provisions for storing materials and waste products inside or under cover;
- Vehicle washing controls;
- Requirements for routine inspections and maintenance of stormwater BMPs;
- Spill prevention and response plans;
- Provisions for maintenance of lawns, gardens, and other landscaped areas;
- Requirements for storage and use of fertilizers, herbicides, and pesticides;
- Pet waste management provisions;
- Provisions for operation and management of septic systems;
- Provisions for solid waste management;
- Snow disposal and plowing plans relative to Wetland Resource Areas;

<sup>3</sup> 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.

## *Massachusetts Stormwater Report Checklist*

- Winter Road Salt and/or Sand Use and Storage restrictions;
  - Street sweeping schedules;
  - Provisions for prevention of illicit discharges to the stormwater management system;
  - Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
  - Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
  - List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.
- X A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.
- X Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:
  - is within the Zone II or Interim Wellhead Protection Area
  - is near or to other critical areas
  - is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
  - involves runoff from land uses with higher potential pollutant loads.
- The Required Water Quality Volume is reduced through use of the LID site Design Credits.
- Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.
- X The BMP is sized (and calculations provided) based on:
  - X The  $\frac{1}{2}$ " or 1" Water Quality Volume or
  - The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.
- The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.
- A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

### **Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)**

- X The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.
- X The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted *prior to* the discharge of stormwater to the post-construction stormwater BMPs.
- The NPDES Multi-Sector General Permit does *not* cover the land use.
- LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.
- All exposure has been eliminated

## *Massachusetts Stormwater Report Checklist*

- All exposure has *not* been eliminated and all BMPs selected are on MassDEP LUHPPL list.
- The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

### **Standard 6: Critical Areas**

- The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.
- Critical areas and BMPs are identified in the Stormwater Report.

### **Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable**

- X The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:
  - Limited Project
  - Small Residential Projects:  
5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
  - 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
  - Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
  - Bike Path and/or Foot Path
  - Redevelopment Project
  - Redevelopment portion of mix of new and redevelopment.
- Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.
- The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

## *Massachusetts Stormwater Report Checklist*

### **Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control**

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures;
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule;
- Maintenance Schedule;
- Inspection and Maintenance Log Form.

- X A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.
- The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has *not* been included in the Stormwater Report but will be submitted *before* land disturbance begins.
- The project is *not* covered by a NPDES Construction General Permit.
- The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.
- X The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

### **Standard 9: Operation and Maintenance Plan**

- X The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:
  - Name of the stormwater management system owners;
  - Party responsible for operation and maintenance;
  - Schedule for implementation of routine and non-routine maintenance tasks;
  - Plan showing the location of all stormwater BMPs maintenance access areas;
  - Description and delineation of public safety features;
  - Estimated operation and maintenance budget; and
  - Operation and Maintenance Log Form.

## *Massachusetts Stormwater Report Checklist*

- The responsible party is *not* the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:
  - A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
  - A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

### **Standard 10: Prohibition of Illicit Discharges**

- X The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;
- X An Illicit Discharge Compliance Statement is attached;
  - NO Illicit Discharge Compliance Statement is attached but will be submitted *prior to* the discharge of any stormwater to post-construction BMPs.

*Standard 1: No new stormwater conveyances (e.g. outfalls) may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth.*

Proposed – All road drainage is being collected and treated at the proposed basin. The new outfall discharges, treated stormwater in compliance with Standards 4 through 6.

Evaluated at a 100-year 24-hour storm event, the peak velocity of any the new outfall is non-erosive to proposed receiving surface.

*Standard 2: Stormwater management systems shall be designed so that the post-development peak discharge rates do not exceed pre-development peak discharge rates. This Standard may be waived for discharges to land subject to coastal storm flowage as defined in 310 CMR 10.04.*

To meet Standard 2, the post-development peak discharge rate must be equal to or less than pre-development rates to prevent storm damage and downstream flooding from the 2-year and the 10-year 24-hour storm events.

Peak discharge rates were calculated and evaluated at four locations for this project. The point of evaluation is shown on the accompanying drainage plans designated as “IP#1(vernal pool), IP#2(Property Line - West), IP#3 Wetlands Northwest corner) and IP#4(Westboro Road - North) “respectively for the pre-development conditions and post-development conditions.

In summary of the detailed calculations attached, the peak discharge rates in cubic feet per second (cfs) Please refer to the Existing & Proposed Conditions Table.

*Standard 3: Loss of annual recharge to ground water shall be eliminated or minimized through the use of environmentally sensitive site design, low impact development techniques, stormwater best management practices, and good operation and maintenance. At a minimum, the annual recharge from the post- development site shall approximate the annual recharge from pre-development conditions based on soil type. This standard is met when the stormwater management system is designed to infiltrate the required recharge volume as determined in accordance with the Massachusetts Stormwater Handbook.*

Hydrologic Group	Volume to Recharge x Total Impervious Area
A	0.60 inches of runoff
C	0.25 inches of runoff
B	0.35 inches of runoff
D	0.10 inches of runoff

Soils underlying the site are defined as hydrologic group “A” \* (\*USDA/NRCS Soil Survey of Middlesex County). From soil testing and soil texture performed in field the soil classification is B.

The required volume of recharge for post-development conditions is calculated as follows;

Total impervious area = 1,811,296 s.f.(0.35 inches/12 inches) = 52,829 c.f.

The volume of recharge provided for post-development conditions is as follows;

BMP utilized – Infiltration Basins

Recharge Basin 1	
Bottom of basin elevation	474.00
Overflow elevation	481.00
Total storage/recharge height	7.0
Total storage/recharge volume	64,442 cf
(see recharge storage table)	

Total Recharge Volume Provided      64,442 cf

BMP utilized – Infiltration Basins

Recharge Basin 2	
Bottom of basin elevation	470.00
Overflow elevation	475.00
Total storage/recharge height	5.0
Total storage/recharge volume	38,325 cf
(see recharge storage table)	

Total Recharge Volume Provided      38,325 cf

### Soils

Field investigations of the soils reveal the following soil profiled for the basins:

See Soil logs.

*Standard 4: Stormwater management systems shall be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS). This standard is met when:*

- a) *Suitable practices for source control and pollution prevention are identified in a long-term pollution prevention plan, and thereafter are implemented and maintained;*
- b) *Structural stormwater best management practices are sized to capture the required water quality volume as determined in accordance with the Massachusetts Stormwater Handbook; and*
- c) *Pretreatment is provided in accordance with the Massachusetts Stormwater Handbook.*

The required Water Quality Volume, the runoff volume requiring 80% TSS removal, is calculated as follows:

Refer to the TSS worksheets.

*Standard 4 requires the development and implementation of suitable practices for source control and pollution prevention. These measures must be identified in a long-term pollution prevention plan.*

The long-term pollution prevention plan is incorporated into the Operation and Maintenance Plan required by Standard 9.

*Standard 5: For land uses with higher potential pollutant loads, source control and pollution prevention shall be implemented in accordance with the Massachusetts Stormwater Handbook to eliminate or reduce the discharge of stormwater runoff from such land uses to the maximum extent practicable.*

The proposed project is not a use with higher potential pollutant loads.

*Standard 6: Stormwater discharges within the Zone II or Interim Wellhead Protection Area of a public water supply and stormwater discharges near or to any other critical area require the use of the specific source control and pollution prevention measures and the specific structural stormwater best management practices determined by the Department to be suitable for managing discharges to such areas, as provided in the Massachusetts Stormwater Handbook.*

The subject property does discharge storm water within the Zone II or Interim Wellhead Protection Area of a public water supply or to any other critical area. Pretreatment has been added to treat runoff prior to discharge into the proposed infiltration basins

*Standard 7: A redevelopment project is required to meet the following Stormwater Management Standards only to the maximum extent practicable:*

It is not a redevelopment project.

*Standard 8: A plan to control construction-related impacts, including erosion, sedimentation, and other pollutant sources during construction and land disturbance activities (construction period erosion, sedimentation, and pollution prevention plan) shall be developed and implemented.*

*During land disturbance and construction activities, project proponents must implement controls that prevent erosion, control sediment movement, and stabilize exposed soils to prevent pollutants from moving offsite or entering wetlands or waters. Land disturbance activities include demolition, construction, clearing, excavation, grading, filling, and reconstruction.*  
*Standard 8, cont'd.*

Construction Period Pollution Prevention Plan and Erosion and Sedimentation Control,  
EPA NPDES – Storm Water Pollution Prevention Plan (SWPPP)

A. Names of Persons or Entity Responsible for Plan Compliance

Owner/Applicant: D&F Afonso Builders Corp.  
189 Main Street  
Milford MA 01757

B. Construction Period Pollution Prevention Measures

1. Inventory materials to be present on site during construction.
2. Train employees and subcontractors in prevention and clean up procedures.
3. All materials stored on site will be stored in their appropriate containers and if possible under a roof or covered.
4. Follow manufacturer's recommendation for disposal of used containers.
5. Store only enough product on site to do the job.
6. On site equipment, fueling and maintenance measures:
  - a. Inspect on-site vehicles and equipment daily for leaks.
  - b. Conduct all vehicle and equipment maintenance and refueling in front of building, away from storm drains.
  - c. Perform major repairs and maintenance off site.
  - d. Use drip pans, drip cloths or absorbent pads when replacing spent fuels.
  - e. Collect spent fuels and remove from site, per Local and State regulations.
  - f. Maintain a clean construction entrance where truck traffic is frequent to reduce soil compaction constant sweeping is required and limit tracking of sediment into streets, sweeping street when silt is observed on street.
7. Stock pile materials, and maintain Erosion Control around the materials where it can easily be accessed. Maintain easy access to clean up materials to include brooms, mops, rags gloves, goggles, sand, sawdust, plastic and metal trash containers.
8. Clean up spills.
  - a. Never hose down "dirty" pavement or impermeable surfaces where fluids have spilled. Use dry clean up methods (sawdust, cat litter and/or rags and absorbent pads).
  - b. Sweep up dry materials immediately. Never wash them away or bury them.
  - c. Clean up spills on dirt areas by digging up and properly disposing of contaminated soil in a certified container and notify a certified hauler for removal.
  - d. Report significant spills to the Fire Department.
9. It is the responsibility of the site superintendent or employees designated by the Applicant to inspect erosion control and repair as needed, also to inspect all on site vehicles for leaks and check all containers on site that may contain hazardous materials daily.

C. Erosion and Sedimentation Control Plan;

1. See Erosion Control Plans.

D. Site Development Plans;

1. See Grading Plans.

E. Construction Plans

1. Construction Sequencing Plan
  - a. Record Order of Conditions - The site superintendent shall be aware of all the Conditions contained within the Order including inspection schedules.
  - b. Install DEP File # Sign.
  - c. Prior to any work on the site including tree/brush clearing, the approved limit of clearing as well as the location of the proposed erosion control devices (such as silt

- fence/straw bales, etc.) must be staked on the ground under the direction of a Massachusetts registered Professional Land Surveyor.
- d. Install silt fence/mulch sock at locations
  - e. Strip off top and subsoil. Stockpile material to be reused away from the wetland, remove excess material from the site. Install and maintain erosion control barrier around stockpile.
  - f. Rough grade site, maintaining a temporary low area/sediment trap away from the wetland.
  - g. Construct drainage outfalls and stilling basin. Stabilize side slopes with loam, seed and mulch.
  - h. Install underground utilities; protect all open drainage structures with erosion/siltation control devices.
  - i. Install binder course of bituminous asphalt.
  - j. Install wearing course of asphalt, and striping (where required).
  - k. Maintain all erosion control devices until site is stabilized and a Certificate of Compliance is issued by the Conservation Commission.
  - l. The Contractor shall be responsible to schedule any required inspections of his/her work.
2. Construction Waste Management Plan
    - a. Dumpster for trash and bulk waste collection shall be provided separately for construction.
    - b. Recycle materials whenever possible (paper, plaster cardboard, metal cans). Separate containers for material are recommended.
    - c. Segregate and provide containers for disposal options for waste.
    - d. Do not bury waste and debris on site.
    - e. Certified haulers will be hired to remove the dumpster container waste as needed. Recycling products will also be removed off site weekly.
    - f. The sewer system is only for disposal of human waste, and substances permitted for disposal in the site sewer permit with the Town DPW.

F. Operation and Maintenance of Erosion and Sedimentation Controls

The operation and maintenance of sedimentation control shall be the responsibility of the contractor. The inspection and maintenance of the stormwater component shall be performed as noted below. The contractor shall have erosion control in place at all times. The contractor, based on future weather reports, shall prepare and inspect all erosion control devices; cleaning, repairing and upgrading is a priority so that the devices perform as per design. Inspect the site during rain events. Don't stay away from the site. At a minimum there should be inspection to assure the devices are not clogged or plugged, or that devices have not been destroyed or damaged during the rain event. After a storm event inspection is required to clean and repair any damage components. Immediate repair is required.

G. Inspection and Maintenance Schedules

1. Inspection must be conducted at least once every 7 days and within 24 hours of the end of a storm event 0.5 inches or greater.
2. Inspection frequency can be reduced to once a month if:
  - a. The site is temporarily stabilized.
  - b. Runoff is unlikely due to winter conditions, when site is covered with snow or ice.
3. Inspections must be conducted by qualified personnel, "qualified personnel" means a person knowledgeable in the principles and practice of erosion and sediment controls and who possess the skills to assess the conditions and take measures to maintain and ensure proper operation, also to conclude if the erosion control methods selected are effective.

4. For each inspection, the inspection report must include: (See attached inspection and maintenance log)
  - a. The inspection date.
  - b. Names, titles of personnel making the inspection.
  - c. Weather information for the period since the last inspection.
  - d. Weather information at the time of the inspection.
  - e. Locations of discharges of sediment from the site, if any.
  - f. Locations of BMP's that need to be maintained.
  - g. Locations where additional BMP's may be required.
  - h. Corrective action required or any changes to the SWPPP that may be necessary.

5. The owner, or their representative, such as the contractor, shall inspect the following in-place work;

Inspection Schedule:

Erosion Control	Weekly
Catch Basins & Drop Inlets	Weekly
Temporary Sedimentation Traps/Basins	Weekly
Street & Parking Area Sweeping	Daily

Please Note: Special inspections shall also be made after a significant rainfall event.

Maintenance Schedule

Erosion Control Devices Failure	Immediately
Catch Basins	Sump 1/4 full of sediment
Temporary Sedimentation Traps/Basins	As needed
Street Sweeping	14 days minimum and prior to any significant rain event.

Please Note: Special maintenance shall also be made after a significant rainfall event.

H. Inspection and Maintenance Log Form. (Log Form Follows)

W2658

**WEEKLY  
Inspection and Maintenance Log  
AFTER CONSTRUCTION**

FOR: w2658  
& After 0.5" Rain

Components	Date
Forebay Area Basin#1&2 - twice a year	
Comments during insp.	
Note corrective measures performed & Date	
Stormceptor prior to Basin#1 -twice a year	
Comments during insp.	
Note corrective measures performed & date	
Catch Basins - twice a year	
Comments during insp.	
Note corrective measures performed & date	
Basin#1 outlet - twice a year	
Comments during insp.	
Note corrective measures performed & date	
Inverts at Headwalls - twice a year	
Comments during insp.	
Note corrective measures performed & date	
Inspector	Title
	Date
Address	Tel#

**WEEKLY  
Inspection and Maintenance Log      FOR: w2658  
AFTER CONSTRUCTION      & After 0.5" Rain**

<u>Components</u>	<u>Date</u>
<b>Notify Cons. Comm. Issues effecting Resource Areas</b>	
Comments during insp.	
Note corrective measures performed & date	
<b>Illicit Drainage Discharge –</b>	
Comments during insp.	
Note corrective measures performed & date	
<b>Access to basin area – twice a year</b>	
Comments during insp.	
Note corrective measures performed & date	
<b>Any Spill Fuel, Chemical- -as-needed</b>	
Comments during insp.	
Note corrective measures performed & date	
<b>Infiltration Basin#1&amp;2 -Once a year</b>	
Comments during insp.	
Note corrective measures performed & date	
<b>Crush Stone Aprons at outlets -Twice a year and replenish stone as needed</b>	
Comments during insp.	
Note corrective measures performed & date	
Inspector _____	Title _____
_____	Date _____

**WEEKLY  
Inspection and Maintenance Log  
DURING CONSTRUCTION**

FOR: W2658  
& After 0.5" Rain

<b>Components</b>	<b>Date</b>
Erosion Control – Weekly	
Comments during insp.	
Note corrective measures performed & Date	
<b>On Site Pavement</b>	
Sweeping – as Needed	
Comments during insp.	
Note corrective measures performed & date	
<b>Catch Basin with Silt</b>	
Sack & Haybales – Monthly	
Comments during insp.	
Note corrective measures performed & date	
<b>Temporary Basin Institute Road Area</b>	
as Needed	
Comments during insp.	
Note corrective measures performed & date	
<b>Temporary Basin Areas</b>	
as Needed	
Comments during insp.	
Note corrective measures performed & date	
Inspector _____	Title _____
_____	Date _____
Address _____	Tel# _____

**WEEKLY  
Inspection and Maintenance Log  
DURING CONSTRUCTION**

FOR: W2658  
& After 0.5" Rain

<b>Components</b>	<b>Date</b>
Notify Cons. Comm. Issues effecting Resource Areas	
Comments during insp.	
Note corrective measures performed & date	
<b>Silt of Public Streets – Daily</b>	
Comments during insp.	
Note corrective measures performed & date	
<b>Stockpile Materials Ring with Haybales – Weekly</b>	
Comments during insp.	
Note corrective measures performed & date	
<b>Any Spill Fuel, Chemical- Daily</b>	
Comments during insp.	
Note corrective measures performed & date	
<b>Temporary Ground Cover Area – Weekly</b>	
Comments during insp.	
Note corrective measures performed & date	
<b>Temporary Stone at Access Drive as Needed</b>	
Comments during insp.	
Note corrective measures performed & date	
Inspector _____	Title _____
_____	Date _____

*Standard 9: A Long –Term Operation and Maintenance (O&M) Plan shall be developed and implemented to ensure that stormwater management systems function as designed.*

The following shall serve as the (O&M) Plan required by Standard 9, as well as the Long Term Pollution Prevention Plan required by Standard 4.

A. Names of Persons or Entity Responsible for Plan Compliance:

Owner/Applicant: Town of Grafton

B. Good housekeeping practices

1. Maintain site, landscaping and vegetation.
2. Sweep and pick up litter on pavements and grounds.
3. Deliveries shall be monitored by owners or representative to ensure that if any spillage occurs, it shall be contained and cleaned up immediately.
4. Maintain pavement and curbing in good repair.

C. Requirements for routine inspections and maintenance of stormwater BMPs

1. Plans: The stormwater Operation and Maintenance Plan shall consist of all Plans, documents and all local state and federal approvals as required for the subject property.
2. Record Keeping:
  - a. Maintain a log of all operation and maintenance activities for at least three years following construction, including inspections, repairs, replacement and disposal (for disposal, the log shall indicate the type of material and the disposal location);
  - b. Make this log available to MassDEP and the Conservation Commission upon request; and
  - c. Allow MassDEP and the Conservation Commission to inspect each BMP to determine whether the responsible party is implementing the Operation and Maintenance Plan.
3. Descriptions and Designs: The Best Management Practices (BMP) incorporated into the design include the following:
  - a. Street Sweeping – Stipulated within the Construction Period Pollution Prevention Plan, the Long Term Pollution Prevention Plan, and the Operation and Maintenance Plan. As the amount of TSS removal is discretionary, no credit was taken within the calculations for this BMP.
  - b. Deep sump catch basins with hoods installed to promote TSS Removal of solids and control floatable pollutants. This BMP has a design rate of 25% TSS Removal.
  - c. Forebay TSS Removal of solids and control floatable pollutants This BMP has a design rate of 25% TSS Removal.
  - d. Infiltration basin to provide the required recharge as well as provide an additional 80% TSS Removal. Refer to TSS Removal Worksheet in Standard 4 for treatment train.
4. BMP Maintenance: After construction it is the responsibility of the owner to perform maintenance. The cleaning of the components of the stormwater management system shall generally be as follows:
  - a. Roadway & Parking Areas: The owner shall keep the roadway swept with a mechanical sweeper semi-annually at a minimum.
  - b. Catch Basins: Shall be cleaned by excavating, pumping or vacuuming. The sediment shall be disposed of off-site by the Owner. Inspect quarterly, remove silt when ¼ full.
  - c. Infiltration Basins: Inspect twice per year and after every major event for the first few months. Clean sediment out of isolator row in basins 2 times per year.

- d. Settling Basins & Forebay: Mow basins at least twice per year. Clean sediment out of basins 2 times per year.
- 5. Access Provisions: All of the components of the storm water system will be accessible by the Owner

D. Spill prevention and response plans

- 1. Inventory materials to be present on site during construction.
- 2. Train employees and subcontractors in prevention and clean up procedures.
- 3. All materials stored on site will be stored in their appropriate containers under a roof.
- 4. Follow manufacturers recommendation for disposal of used containers.
- 5. Store only enough product on site to do the job.
- 6. On site equipment, fueling and maintenance measures:
  - a. Inspect on-site vehicles and equipment daily for leaks.
  - b. Conduct all vehicle and equipment maintenance and refueling in one location, away from storm drains.
  - c. Perform major repairs and maintenance off site.
  - d. Use drip pans, drip cloths or absorbent pads when replacing spent fuels.
  - e. Collect spent fuels and remove from site.
- 7. Clean up spills.
  - a. Never hose down "dirty" pavement or impermeable surfaces where fluids have spilled. Use dry clean up methods (sawdust, cat litter and/or rags and absorbent pads).
  - b. Sweep up dry materials immediately. Never wash them away or bury them.
  - c. Clean up spills on dirt areas by digging up and properly disposing of contaminated soil.
  - d. Report significant spills to the Fire Department, Conservation Commission and Board of Health.

E. Provisions for maintenance of lawns, gardens, and other landscaped areas

Use only organic fertilizer. Dispose of clippings outside of the 100 foot buffer zone to the adjacent wetland.

F. Requirements for storage and use of herbicides, and pesticides

The application of herbicides or pesticides will be done by professional certified contractor.

G. Provisions for operation and management of septic system

The system shall be inspected and maintained according to the schedule noted on the approved Board of Health plan.

H. Provisions for solid waste management

- 1. Waste Management Plan
  - a. Dumpster for trash and bulk waste collection shall be stored inside or under a roof.
  - b. Recycle materials whenever possible (paper, plaster cardboard, metal cans). Separate containers for material is recommended.
  - c. Do not bury waste and debris on site.
  - d. Certified haulers will be hired to remove the dumpster container waste as needed. Recycling products will also be removed off site weekly.

I. Snow disposal and plowing plans relative to Wetland Resource Areas

Snow storage is adequate around the site for small storm events. The owner will have to coordinate snow removal to off site location due to the developments size and location of wetlands.

J. Winter Road Salt and/or Sand Use and Storage restrictions

No sand, salt, or chemicals for de-icing will be stored outside.

K. Street and parking lot sweeping schedules

Sweeping, the act of cleaning pavement can be done by mechanical sweepers, vacuum sweeper or hand sweeper. The quantity of sand is a direct correlation with the treatment of ice and snow and the types of chemicals and spreaders that are being used on site to manage snow. If a liquid de-icer such as calcium chloride is used as a pretreatment to new events the amount of sand is minimized. Sweeping for this site should be done semi-annually at a minimum. Collecting the particulate before it enters the catch basins is cheaper and more environmentally friendly than in a catch basin mixing with oils and greases in the surface water runoff in catch basins.

L. Provisions for prevention of illicit discharges to the stormwater management system

The discharge into the stormwater system is not being violated, see attachment for illicit discharges compliance.

M. Training the staff or personnel involved with implementing Long-Term Pollution Prevention Plan

The owner shall develop policies and procedures for containing the illicit spilling of oils, soda, beer, paper and litter. These wastes provide a degrading of the water quality. The placement of signs and trash barrels with lids around the site would contribute to a clean water quality site conditions.

N. List of Emergency contacts for implementing Long-Term Pollution Prevention Plan:

Town of Grafton

*Standard 10: All illicit discharges to the stormwater management system are prohibited.*

*Standard 10 prohibits illicit discharges to stormwater management systems. The stormwater management system is the system for conveying, treating, and infiltrating stormwater on site, including stormwater best management practices and any pipes intended to transport stormwater to the ground water, a surface water, or municipal separate storm sewer system. Illicit discharges to the stormwater management system are discharges that are not entirely comprised of stormwater. Notwithstanding the foregoing, an illicit discharge does not include discharges from the following activities or facilities: firefighting, water line flushing, landscape irrigation, uncontaminated ground water, potable water sources, foundation drains, air conditioning condensation, footing drains, individual resident car washing, flows from riparian habitats and wetlands, dechlorinated water from swimming pools, water used for street washing and water used to clean residential buildings without detergents.*

*Proponents of projects within Wetlands jurisdiction must demonstrate compliance with this requirement by submitting to the issuing authority an Illicit Discharge Compliance Statement verifying that no illicit discharges exist on the site and by including in the pollution prevention plan measures to prevent illicit discharges to the stormwater management system, including wastewater discharges and discharges of stormwater contaminated by contact with process wastes, raw materials, toxic pollutants, hazardous substances, oil, or grease. The Illicit Discharge Compliance Statement may be filed with the Notice of Intent. If the Illicit Discharge Compliance Statement has not been filed, the Final Order of Conditions shall require the submission of an Illicit Discharge Compliance Statement prior to the start of construction. The issuing authority should not issue a Certificate of Compliance until it has determined that the Illicit Discharge Compliance Statement has been submitted, has reviewed the Illicit Discharge Compliance Statement, and has verified that there are no illicit discharges at the site.*

(Illicit Discharge Compliance Statement Follows)

**Attachment**  
**Illicit Discharge Compliance Statement**

It is the intent of the Applicant D&F Afonso Builders Corp. to control illicit disposal into the storm drainage system. There will be no connection to the storm water system to inadvertently direct other types of liquids, chemicals or solids into the storm drainage system. The Applicant will also promote a clean Green Environment by mitigating spills onto pavements; oils, soda, chemicals, pet waste, debris and litter.

Respectfully Acknowledged,

  
\_\_\_\_\_  
D&F Afonso Builders Corp



# Guerriere & Halnon, Inc.

ENGINEERING & LAND SURVEYING

www.guerriereandhalnon.com

Est. 1972

Whitinsville Office  
1029 Providence Road  
Whitinsville, MA 01588-2121  
Phone: (508) 234-6834  
Fax: (508) 234-6723

Milford Office  
333 West Street  
P.O. Box 235  
Milford, MA 01757-0235  
Phone: (508) 473-6630  
Fax: (508) 473-8243

W-2658

## VILLAGE AT INSTITUTE PHASING NARRATIVE

### Franklin Office

55 West Central Street  
Franklin, MA 02038-3807  
Phone (508) 528-3221  
Fax (508) 528-7921

#### Phase 1

- Installation of the force main from the existing sewer in Westboro Road to the proposed pump station.
- Construction of the sewer pump station
- Construction of the gravity sewer from the pump station up Westboro Road and cross country to the end of Brooke St.
- Construction of the drainage basins
- Installation of sewer, water and drainage along the entire length of Brooke Street.
- Installation of sewer, water, and drainage along the entire length of Audriana Lane
- Construct water line connection to Institute Road from Brooke Street and Audriana Lane
- Install base coarse of pavement along entire length of Audriana Lane up to its intersection with Brooke Street.
- Install base coarse of pavement along Brooke Street from station 0+0 to 16+50, the intersection with Audriana Lane.

#### Phase 2

- Apply for lot releases lots 1-13, 18-34, and lots 42-45.
- Reconstruct a portion of Institute Rd. per approved plan and profile. Brooke Street and Audriana lane to be utilized to detour traffic around Institute Road construction area.

#### Phase 3

- Construct houses on lots released by the Planning Board.
- Construct Brooke Street from station 16+50 to the cul-de-sac
- Install water, sewer, and drainage in Dylan Way.
- Install base course of pavement Brooke Street form station 16+50 to the end of the cul-de-sac.
- Install base course of pavement Dylan Way from 0+0 to the end of the cul-de-sac.
- Construct cross country walkway from Institute road to Dylan Way.

#### Phase 4

- Apply for lot releases for 14-17, and lots 35-41
- Construct houses on lots 14-17 and lots 35-41

#### Phase 5

- Install finished pavement and street monuments
- Prepare as-built plans, as-built profiles, street layout plans, and legal descriptions.
- File application for Certificate of Completion
- Request acceptance of roadways as public ways.



**HYDROLOGIC & HYDRAULIC REPORT  
“The Village At Institute Road”  
In  
Grafton Main, Massachusetts**

September 13, 2016  
Rev. 2-1-17

**Prepared for:**

D&F Afonso Builders, Inc.  
189 Main Street  
Milford MA 01757

**Prepared by:**

Guerriere & Halnon Inc  
333 West Street  
Milford, MA 01757

**HYDROLOGIC & HYDRAULIC REPORT**  
**"The Village At Institute Road", Grafton Ma**  
**Rev. 2-1-17**

**SITE LOCATION & DESCRIPTION**

The site is located off of Institute Road in Grafton Massachusetts. Figure 1 shows the site locus.

The project locus contains approximately 62.9 acres of land. The existing property is presently undeveloped and consists of one lot. The site consists of mainly wooded area. The parcel has many cart paths that run throughout it as shown on Pre-Development Drainage Map. The existing topography slopes from southeast to northwest toward the wetland located in the northwest corner of the lot. The parcel also has a vernal pool located in the center of the project adjacent to Institute Road.

**PROJECT DESCRIPTION**

The project proponent proposes to construct a 46 lot residential development. This development is known as "The Village At Institute Road" and consists of 46 single family homes serviced by public water and sewer and driveway as shown conceptual on the Definitive Plans. The development also includes construction of three 26' wide paved roadways as shown on the plans. The proposed drainage system will consists of catch basins and drain manholes along the proposed roadways and directed to a forebay and infiltration basin.

**DESCRIPTION OF EXISTING DRAINAGE FACILITIES**

In present condition the project was divided into 4 drainage areas with four interest points as shown on the drainage map. The first interest point is an isolated wetland located at the center of the site adjacent to Institute Road. The second interest point is the property line to the west of the project. The third interest point is the wetland located in the northwest corner and the fourth interest point is the property line to the north. The drainage areas are as follows:

1. Drainage Area E1 consists of woodland and a portion of Institute Road. This Drainage Area flows from the site toward the wetland located adjacent to the Institute Road. This is a vernal pool and isolated wetland(IP#1).
  2. Drainage Area E2 consists of woodland area with gravel cart paths that run through the drainage area. This runoff flows toward the west property line.(IP#2)
  3. Drainage Area E3 consists of woodland area, existing site adjacent to the project. This drainage area flows overland toward large wetland located in the northwest corner of the lot. (#IP3)
  4. Drainage Area E4 consists of woodland area that flows overland offsite toward the north. (IP#4)
5. All Drainage Areas will have roof area directed into recharge areas.

Please refer to the Pre-Development Plan.

**DESCRIPTION OF PROPOSED DRAINAGE FACILITIES**

In the proposed state there will be four (4) general runoff areas. They are as follows:

1. Drainage Area 1P will be collected and directed runoff into a water quality grass swale toward the existing wetland located adjacent to Institute Road, which is also a vernal pool. This area consists of a grass area along the back of the proposed house, portion of driveways and roofs from the proposed houses and woodland areas that will remain undisturbed and portion of Institution Road. (#IP1P)
2. Drainage area 2P will be direct runoff toward the west property line. This area consists of a grass area in back yards along the new street and portion of driveways and roofs from the proposed houses and portion of proposed street. (#IP2P)
3. Drainage area 3P will be collected by catch basins in proposed roadways and directed into proposed stormceptor then forebay and then into proposed infiltration basin. The area will discharge into wetlands located in the northwest corner of project. This area consists of a grass area, wooded area, driveway and portion of the new street as well as portion of existing street. (#IP3P)
4. Drainage area 4P will be direct runoff toward Westboro Road and the area consists of lawn area, wooded area, driveways and roof area.
5. Drainage area 5P will be runoff generated from wooded and grass area that flows directly into the wetlands.
6. Drainage area 6P will be runoff collected by drainage channel along portion of new street and directed into basin#2. This area consists of a grass area in the front yards along the new street and portion of driveways and roofs from the proposed houses and portion of proposed street. (#IP3P).

### CALCULATION PROCEDURE

Procedures developed by the U. S. Department of Agriculture Soil Conservation Service (SCS) as found in Technical Release 20 (TR20) were used to determine the rates and volumes of runoff generated by the study area. Calculations were performed using the computer program "HydroCAD" by Applied Microcomputer Systems, which has incorporated these SCS procedures. Pipe capacities were determined using Manning's Equations.

Runoff Areas are shown on the attached Drainage Area Plans. Calculation was done for the Two (2), Ten (10), Twenty Five (25), Fifty (50) and One Hundred-(100) Year storms. Rainfall depths used for these storms were 3.28, 4.89, 6.22, 7.42 and 8.84 inches respectively. Calculation summaries are attached to this report.

### SOIL MAPS

The SCS has also performed soil mapping of the South Worcester County. The soils mapping indicate that the site is located within Hydrologic Soil Group B, See the Pre & Post Development Plans. Deep hole tests and perc tests were done throughout the Site refer, to the Grading Plan for locations. Deep test hole results indicate that the proposed underground basins are located in loamy sand & gravelly material and have a perc rate of less than 10 minutes per inch.

### POLLUTANT REMOVAL

This project will incorporate facilities that will collect stormwater pollutants. Collection of pollutants will be accomplished by:

- |                           |     |
|---------------------------|-----|
| a. Deep sump catch basins | 25% |
| b. Stormceptor            | 80% |
| c. Infiltration Basins    | 80% |
| e. Grass Swale            | 50% |

(Refer to attached worksheets)

**SUMMARY REACH IP#1**  
 (Wetlands → Vernal Pool)

Storm Event	Pre-Development		Post-Development	
2 yr.	1.78 cfs	0.304 af	1.20 cfs	0.272af
10 yr.	7.69 cfs	0.952 af	4.77 cfs	0.790 af
25 yr.	14.31 cfs	1.651 af	8.67 cfs	1.335 af
50 yr.	21.07 cfs	2.371 af	12.62 cfs	1.888 af
100 yr.	29.73 cfs	3.303 af	17.69 cfs	2.598 af

**SUMMARY REACH IP#2**  
 (West Property Line)

Storm Event	Pre-Development		Post-Development	
2 yr.	3.08 cfs	0.438 af	1.53 cfs	0.313 af
10 yr.	13.10 cfs	1.321 af	5.05 cfs	0.831 af
25 yr.	23.98 cfs	2.261 af	8.71 cfs	1.360 af
50 yr.	35.00 cfs	3.223 af	12.36 cfs	1.888 af
100 yr.	49.05 cfs	4.462 af	16.94 cfs	2.558 af

**SUMMARY REACH IP#3**  
 (Wetlands Northwest Corner PArcel)

Storm Event	Pre-Development		Post-Development	
2 yr.	4.33	cfs	0.730	af
10 yr.	16.16	cfs	2.133	af
25 yr.	28.80	cfs	3.613	af
50 yr.	41.53	cfs	5.118	af
100 yr.	57.70	cfs	7.051	af

**SUMMARY REACH IP#4**  
 (North Property Line)

Storm Event	Pre-Development		Post-Development	
2 yr.	1.92	cfs	0.292	af
10 yr.	7.88	cfs	1.117	af
25 yr.	14.32	cfs	1.915	af
50 yr.	20.86	cfs	2.732	af
100 yr.	29.19	cfs	3.785	af

**Basin Summary Table**

**BASINS PROPOSED CONDITIONS**

<b>BASIN</b>	<b>UNITS</b>	<b>100 YR.</b>	<b>50 YR.</b>	<b>25 YR.</b>	<b>10 YR.</b>	<b>2 YR</b>
1	Qin = CFS	35.54	27.54	20.93	13.90	6.22
	Qout = CFS	11.05	8.45	4.98	3.60	1.32
	ELEV. = FT	380.39	379.35	378.43	377.08	375.66
	VOL. ST. = cf	72,625	56,915	44,354	28,066	13,641
2	Qin = CFS	22.11	16.34	11.71	7.02	2.33
	Qout = CFS	12.98	9.89	6.35	4.19	0.99
	ELEV. = FT	374.66	373.74	372.90	371.77	370.61
	VOL. ST. = cf	34,912	26,136	19,187	11,359	5,202

## **Supporting Calculations**

Institute Village, MA  
Feb. 1, 2017

G&H Project W-2658

Riprap Stone Sizing – Drainage Swale Outfalls

Method – ARS Rock Chutes (Slopes 2%-40%)

Reference: National Engineering Handbook, TS14C-8

#1 - Rock Apron-Basin 1 outlet (HydroCAD)

Slope = 0.028 ft/ft

q (100-yr) = 10.67 cfs

$$D_{50} = 12(1.923qS^{1.5})^{0.529}$$

D<sub>50</sub> = 4" required

D<sub>50</sub> = 6" provided

#2 - Rock Apron-Basin 1 outlet (HydroCAD)

Slope = 0.03 ft/ft

q (100-yr) = 6.30 cfs

$$D_{50} = 12(1.923qS^{1.5})^{0.529}$$

D<sub>50</sub> = 3" required

D<sub>50</sub> = 6" provided

Version 1, Automated: Mar. 4, 2008

- INSTRUCTIONS:**
1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
  2. Select BMP from Drop Down Menu
  3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Location: [Basin#] 3P

BMP <sup>1</sup>	TSS Removal Rate <sup>1</sup>	Starting TSS Load*	Amount Removed (C*D)	Remaining Load (D-E)
Deep Sump and Hooded Catch Basin	0.25	1.00	0.25	0.75
Stormwater	0.80	0.75	0.60	0.15
Infiltration Basin	0.80	0.15	0.12	0.03
	0.00	0.03	0.00	0.03
	0.00	0.03	0.00	0.03
<b>Total TSS Removal =</b>				97%
Project: W2658	Prepared By: Peter M Lavale	Separate Form Needs to be Completed for Each Outlet or BMP Train		
Date: 23-Aug-16		*Equals remaining load from previous BMP (E) which enters the BMP		

## TSS Removal Calculation Worksheet

Non-automated TSS Calculation Sheet  
must be used if Proprietary BMP Proposed  
1. From MassDEP Stormwater Handbook Vol. 1

**INSTRUCTIONS:**

1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Location: (Bassin#2) 6P

BMP <sup>1</sup>	C	TSS Removal Rate <sup>1</sup>	D	Starting TSS Load*	E	Amount Removed (C*D)	F	Remaining Load (D-E)
Grass Channel	0.50			1.00		0.50		0.50
Infiltration Basin	0.80			0.50		0.40		0.10
	0.00			0.10		0.00		0.10
	0.00			0.10		0.00		0.10
	0.00			0.10		0.00		0.10

# TSS Removal Calculation Worksheet

**Total TSS Removal =**

90%

Separate Form Needs to  
be Completed for Each  
Outlet or BMP Train

Project: W-2658  
 Prepared By: Peter M Lavoie  
 Date: 23-Aug-16

Non-automated TSS Calculation Sheet  
 must be used if Proprietary BMP Proposed  
 1. From MassDEP Stormwater Handbook Vol. 1

STAGE-STORAGE WORKSHEET					
		GUERRIERE & HALNON, INC. ENGINEERING & LAND SURVEYING 333 WEST STREET, MILFORD, MASS 01757			
DATE:	2/1/2017			CLIENT:	D&F
PROJECT NUMBER:	W2658			CALCULATED BY:	
BASIN NUMBER:	Recharge			CHECKED BY:	
LOCATION:	GRAFTON				
ELEVATION	AREA	AVERAGE AREA	VERTICAL INTERVAL	VOLUME INCREMENTAL	VOLUME CUMULATIVE
(FEET)	(FT <sup>2</sup> )	(FT <sup>2</sup> )	(FT)	(FT <sup>3</sup> )	(FT <sup>3</sup> )
474.0	7184				0
476.0	9666	8425	2	16850	16850
478	12357	11012	2	22023	38873
480	15306	13832	2	27663	66536
481.0	16900	16103	1	16103	82639

STAGE-STORAGE WORKSHEET					
		GUERRIERE & HALNON, INC. ENGINEERING & LAND SURVEYING 333 WEST STREET, MILFORD, MASS 01757			
	DATE:	2/1/2017		CLIENT:	D&F
PROJECT NUMBER:	W2658		CALCULATED BY:		
BASIN NUMBER:	Recharge2		CHECKED BY:		
LOCATION:	GRAFTON				
ELEVATION	AREA	AVERAGE AREA	VERTICAL INTERVAL	VOLUME INCREMENTAL	VOLUME CUMULATIVE
(FEET)	(FT <sup>2</sup> )	(FT <sup>2</sup> )	(FT)	(FT <sup>3</sup> )	(FT <sup>3</sup> )
369.0	1600				0
370.0	3750	2675	1	2675	2675
372	6400	5075	2	10150	12825
374	9300	7850	2	15700	28525
375.0	10300	9800	1	9800	38325

STAGE-STORAGE WORKSHEET					
		GUERRIERE & HALNON, INC. ENGINEERING & LAND SURVEYING 333 WEST STREET, MILFORD, MASS 01757			
DATE:	2/1/2017			CLIENT:	D&F
PROJECT NUMBER:	W2658	CALCULATED BY:			
BASIN NUMBER:	Forebay	CHECKED BY:			
LOCATION:	GRAFTON				
ELEVATION	AREA	AVERAGE AREA	VERTICAL INTERVAL	VOLUME INCREMENTAL	VOLUME CUMULATIVE
(FEET)	(FT <sup>2</sup> )	(FT <sup>2</sup> )	(FT)	(FT <sup>3</sup> )	(FT <sup>3</sup> )
483.0	1320				0
484.0	2502	1911	1	1911	1911
486	2426	3951	2	7902	9813

	STAGE-STORAGE WORKSHEET								
GUERRIERE & HALNON, INC. ENGINEERING & LAND SURVEYING 333 WEST STREET, MILFORD, MASS 01757									
DATE:	2/1/2017			CLIENT:	D&F				
PROJECT NUMBER:	W2658			CALCULATED BY:					
BASIN NUMBER:	Forebay2			CHECKED BY:					
LOCATION:	GRAFTON								
ELEVATION	AVERAGE AREA (FEET)	VERTICAL AREA (FT <sup>2</sup> )	INTERVAL (FT)	VOLUME INCREMENTAL (FT <sup>3</sup> )	VOLUME CUMULATIVE (FT <sup>3</sup> )				
370.0	550				0				
372.0	1617	1084	2	2167	2167				
373	2769	3951	1	3951	6118				

## Hydrograph for Pond 5PND: BASIN#1

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)	Discarded (cfs)	Primary (cfs)
0.00	0.00	0	374.00	0.00	0.00	0.00
2.50	0.00	0	374.00	0.00	0.00	0.00
5.00	0.00	0	374.00	0.00	0.00	0.00
7.50	0.08	57	374.01	0.02	0.02	0.00
10.00	1.11	3,116	374.42	0.18	0.18	0.00
12.50	28.73	61,177	379.64	9.29	0.35	8.94
15.00	2.86	44,771	378.46	5.05	0.31	4.75
17.50	1.42	25,377	376.83	3.32	0.25	3.07
20.00	0.95	14,127	375.71	1.46	0.22	1.24
22.50	0.75	12,047	375.49	0.86	0.21	0.65
25.00	0.00	10,227	375.28	0.42	0.21	0.21
27.50	0.00	7,837	375.00	0.20	0.20	0.00
30.00	0.00	6,074	374.79	0.19	0.19	0.00
32.50	0.00	4,366	374.58	0.19	0.19	0.00
35.00	0.00	2,715	374.37	0.18	0.18	0.00
37.50	0.00	1,120	374.15	0.17	0.17	0.00
40.00	0.00	80	374.01	0.03	0.03	0.00
42.50	0.00	4	374.00	0.00	0.00	0.00
45.00	0.00	0	374.00	0.00	0.00	0.00
47.50	0.00	0	374.00	0.00	0.00	0.00
50.00	0.00	0	374.00	0.00	0.00	0.00
52.50	0.00	0	374.00	0.00	0.00	0.00
55.00	0.00	0	374.00	0.00	0.00	0.00
57.50	0.00	0	374.00	0.00	0.00	0.00
60.00	0.00	0	374.00	0.00	0.00	0.00
62.50	0.00	0	374.00	0.00	0.00	0.00
65.00	0.00	0	374.00	0.00	0.00	0.00
67.50	0.00	0	374.00	0.00	0.00	0.00
70.00	0.00	0	374.00	0.00	0.00	0.00

**post developmen 1-17**

Type III 24-hr 100YR-REV Rainfall=8.84"

Prepared by {enter your company name here}

Printed 2/1/2017

HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC

**Hydrograph for Pond 7P: BASIN#2**

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)	Discarded (cfs)	Primary (cfs)
0.00	0.00	0	369.00	0.00	0.00	0.00
2.50	0.00	0	369.00	0.00	0.00	0.00
5.00	0.00	0	369.00	0.00	0.00	0.00
7.50	0.00	0	369.00	0.00	0.00	0.00
10.00	0.33	425	369.23	0.05	0.05	0.00
12.50	21.76	22,715	373.34	7.90	0.20	7.71
15.00	2.65	12,013	371.87	4.44	0.15	4.29
17.50	1.32	6,673	370.92	1.51	0.12	1.39
20.00	0.86	5,133	370.59	0.97	0.11	0.86
22.50	0.68	4,592	370.47	0.72	0.10	0.62
25.00	0.05	3,719	370.27	0.33	0.10	0.23
27.50	0.00	2,520	369.96	0.09	0.09	0.00
30.00	0.00	1,790	369.75	0.08	0.08	0.00
32.50	0.00	1,158	369.53	0.06	0.06	0.00
35.00	0.00	624	369.32	0.05	0.05	0.00
37.50	0.00	186	369.11	0.04	0.04	0.00
40.00	0.00	6	369.00	0.00	0.00	0.00
42.50	0.00	0	369.00	0.00	0.00	0.00
45.00	0.00	0	369.00	0.00	0.00	0.00
47.50	0.00	0	369.00	0.00	0.00	0.00
50.00	0.00	0	369.00	0.00	0.00	0.00
52.50	0.00	0	369.00	0.00	0.00	0.00
55.00	0.00	0	369.00	0.00	0.00	0.00
57.50	0.00	0	369.00	0.00	0.00	0.00
60.00	0.00	0	369.00	0.00	0.00	0.00
62.50	0.00	0	369.00	0.00	0.00	0.00
65.00	0.00	0	369.00	0.00	0.00	0.00
67.50	0.00	0	369.00	0.00	0.00	0.00
70.00	0.00	0	369.00	0.00	0.00	0.00

# ***DRAINAGE ANALYSIS***

HydroCAD Calculations – Existing Conditions

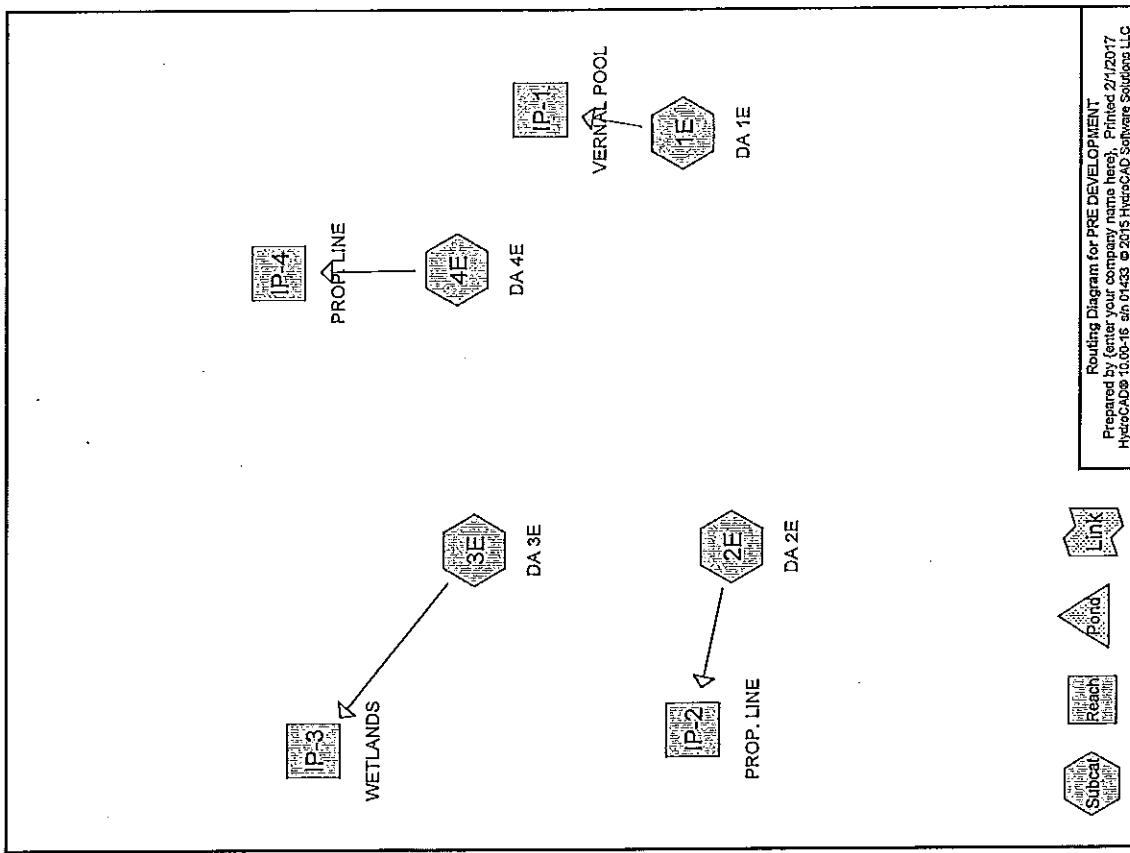
**PRE DEVELOPMENT**

Prepared by {enter your company name here},  
 HydroCAD® 10.00-16 sn 01433 © 2015 HydroCAD Software Solutions LLC

Printed 2/1/2017  
 Page 2

**Area Listing (all nodes)**

Area (acres)	CN	Description (subcatchment-numbers)
6.981	61	>75% Grass cover, Good, HSG B (3E, 4E)
0.982	82	Dirt roads, HSG B (1E, 2E)
0.786	98	Paved parking & roofs (3E)
0.275	98	Water Surface, HSG B (4E)
53.916	58	Woods/grass comb., Good, HSG B (1E, 2E, 3E, 4E)



**PRE DEVELOPMENT**  
Prepared by [enter your company name here]  
HydroCAD® 10.00-16 sn 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 2YR Rainfall=3.28"  
Printed 2/1/2017  
Page 3

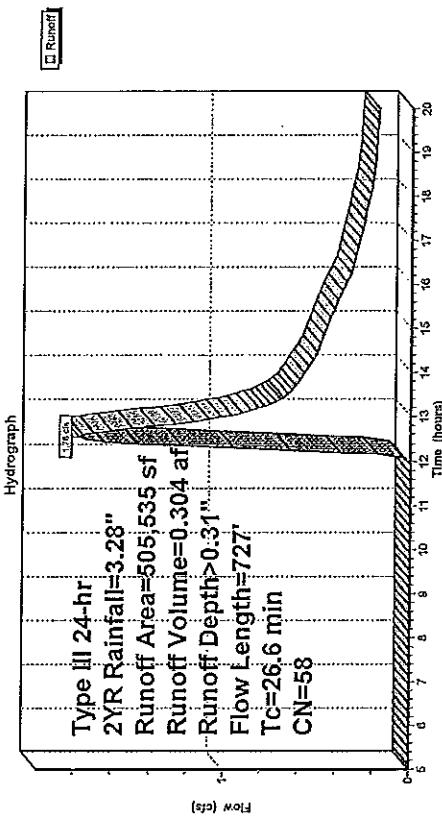
**Summary for Subcatchment 1E: DA 1E**

Runoff = 1.78 cfs @ 12.56 hrs. Volume=

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs  
Type III 24-hr 2YR Rainfall=3.28"

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	50	0.0200	0.07	Sheet Flow, TRAVEL PATH A TO B Woods: Light underbrush, n= 0.400 P2= 3.20" Shallow Concentrated Flow, TRAVEL PATH B TO C Woodland Kv= 5.0 fols	
14.3	677	0.0250	0.79		
26.6	727	Total			

**Subcatchment 1E: DA 1E**



**PRE DEVELOPMENT**  
Prepared by [enter your company name here]  
HydroCAD® 10.00-16 sn 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 2YR Rainfall=3.28"  
Printed 2/1/2017  
Page 4

**Summary for Subcatchment 2E: DA 2E**

Runoff = 3.08 cfs @ 12.37 hrs. Volume=

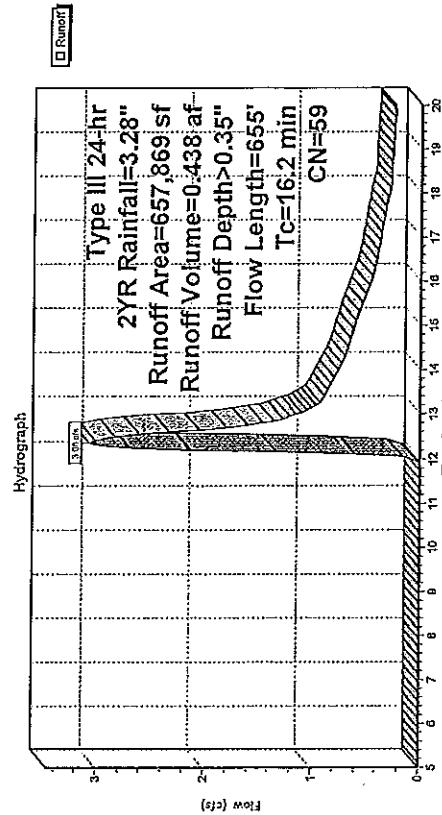
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs  
Type III 24-hr 2YR Rainfall=3.28"

Area (sf)	CN	Description
496.983	58	Woods/grass comb., Good, HSG B
8,552	82	Dirt roads, HSG B
505.535	58	Weighted Average
505.535	58	100.00% Perious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.9	30	0.0500	0.05	Sheet Flow, TRAVEL PATH A TO B Woods: Dense underbrush n= 0.800 P2= 3.20" Shallow Concentrated Flow, TRAVEL PATH B TO C Woodland Kv= 5.0 fops	
6.3	625	0.1100	1.66		
16.2	655	Total			

**Subcatchment 2E: DA 2E**



**PRE DEVELOPMENT** Type III / 24-hr 2YR Rainfall=3.28" Prepared by {enter your company name here} Printed 2/1/2017 HydroCAD® 10.00-16 str-01433 © 2015 HydroCAD Software Solutions LLC Page 6

Summary for Subcatchment 3E: DA 3E

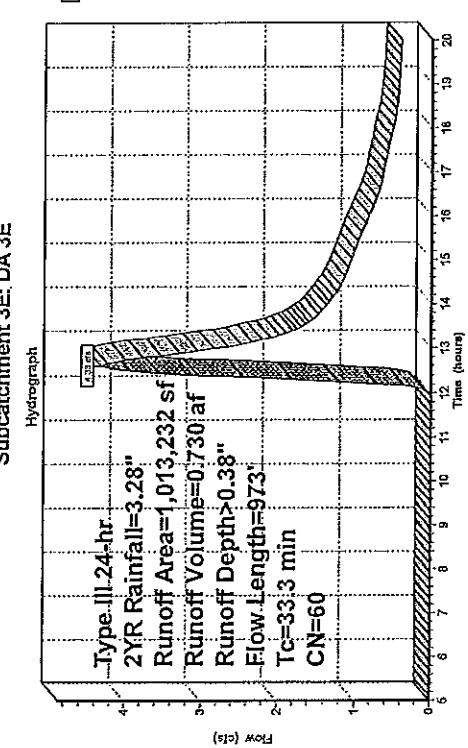
Runoff	=	4.33 cfs @ 12.62 hrs, Volume=	0.730 ac, Depth > 0.38"		
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs Type III 24-hr 2'R Rainfall=3.28"					
Area (sf)	CN	Description			
682,936	58	Wood/grass comb., Good, HSG B			
34,219	98	Paved parking & roofs			
286,077	61	>75% Grass cover, Good, HSG B			
1,013,232	60	Weighted/Average			
979,013	98	95.62% Previous Area			
34,219	98	3.38% Impervious Area			
Tc	Length	Slope	Velocity	Capacity	Description
(min.)	(feet)	(ft/ft)	(ft/sec)	(cfs)	
21.5	50	0.0200	0.04		Sheet Flow, TRAVEL PATH A TO B
10.5	777	0.0610	1.23		Woods: Dense underbrush n = 0.800 P2= 3.20"
1.3	146	0.0360	1.90		Shallow Concentrated Flow, TRAVEL PATH B TO C
33.3	973	Total			Woodland Kt = 5.0 ips
					Shallow Concentrated Flow, TRAVEL PATH C TO D
					Nearly Bare & Untilled Kt = 10.0 ips

Runoff = 1.98 cfs @ 12.70 hrs, Volume= 0.369 af, Depth> 0.34"  
 Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, qf= 0.05 hrs  
 Type II 24-hr 2yr Rainfall= 3.28"

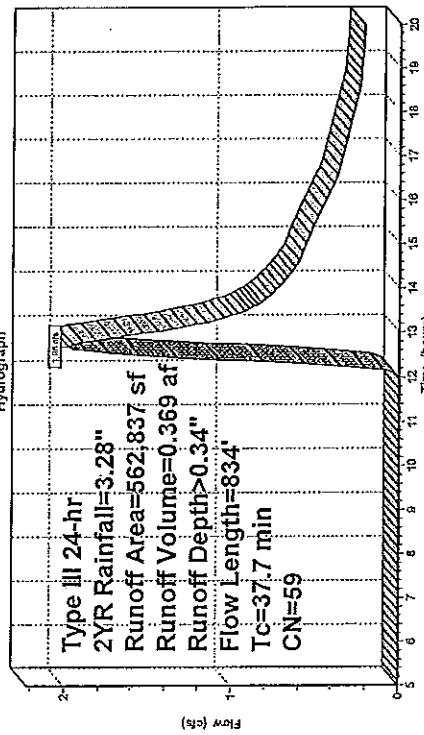
Summary for Subcatchment 4E: DA 4E

Runoff	=	1.98 cfs @ 12.70 hrs, Volume=	0.369 af, Depth> 0.34"
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs			
Type III 24-hr 2TR Rainfall=3.28"			
Area (sf)	CN	Description	
532,837	58	Wood/grass comb, Good, HSG B	
18,000	98	Water Surface, HSG B	
18,000	61	>75% Grass cover, Good, HSG B	
562,837	59	Weighted Average	
560,837		97.87% Previous Area	
12,000		2.13% Impervious Area	
Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)
28.3	50	0.0100	0.03
9.4	784	0.0770	1.39
37.7	834	Total	
			Sheet Flow, TRAVEL PATH A TO B
			Woods: Dense underbrush n= 0.800 P2= 3.20"
			Shallow Concentrated Flow, TRAVEL PATH B TO C
			Woodland Ky= 5.0 fps

## **Subcatchment 4E: DA 4E**



Subcatchment 3E: DA 3E



ԿՐԵԱՑՈՒԹՅԻ

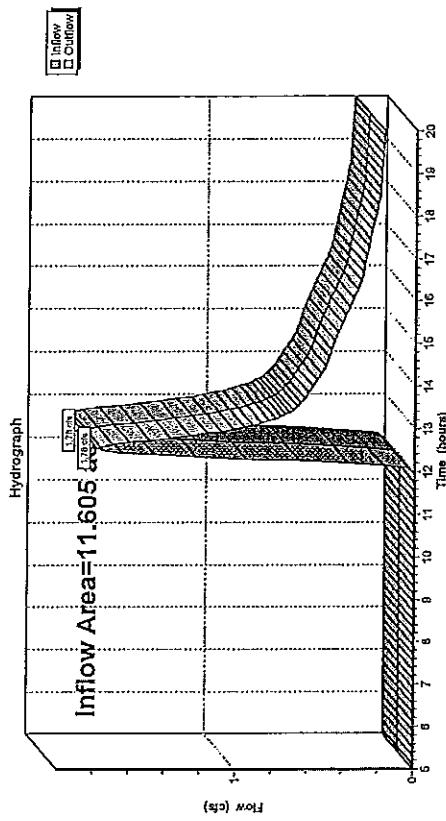
**PRE DEVELOPMENT**  
 Prepared by {enter your company name here}  
 HydroCAD® 10.00-16 sn:01433 © 2015 HydroCAD Software Solutions LLC  
 Type III 24-hr 2YR Rainfall=3.28"  
 Printed 2/1/2017  
 Page 7

**PRE DEVELOPMENT**  
 Prepared by {enter your company name here}  
 HydroCAD® 10.00-16 sn:01433 © 2015 HydroCAD Software Solutions LLC  
 Type III 24-hr 2YR Rainfall=3.28"  
 Printed 2/1/2017  
 Page 7

**Summary for Reach IP-1: VERNAL POOL**

Inflow Area = 11.605 ac, 0.00% Impervious, Inflow Depth > 0.31" for 2YR event  
 Inflow = 1.78 cfs @ 12.56 hrs, Volume= 0.304 af  
 Outflow = 1.78 cfs @ 12.56 hrs, Volume= 0.304 af, Atten= 0%, Lag= 0.0 min  
 Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

**Reach IP-1: VERNAL POOL**

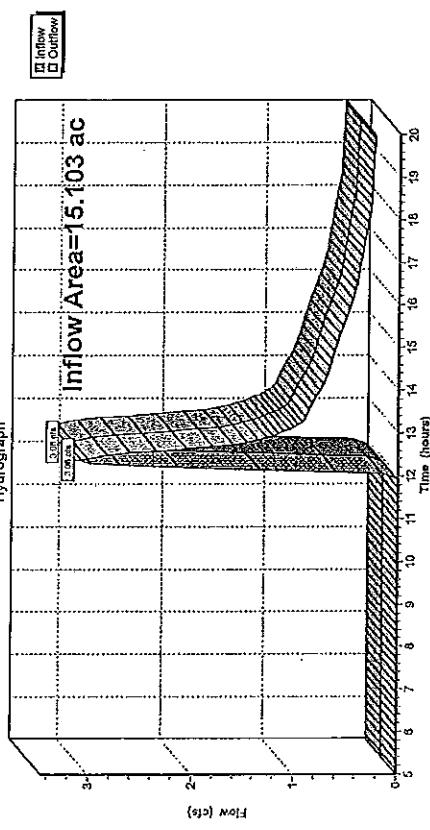


**PRE DEVELOPMENT**  
 Prepared by {enter your company name here}  
 HydroCAD® 10.00-16 sn:01433 © 2015 HydroCAD Software Solutions LLC  
 Type III 24-hr 2YR Rainfall=3.28"  
 Printed 2/1/2017  
 Page 8

**Summary for Reach IP-2: PROP. LINE**

Inflow Area = 15.103 ac, 0.00% Impervious, Inflow Depth > 0.35" for 2YR event  
 Inflow = 3.08 cfs @ 12.37 hrs, Volume= 0.438 af  
 Outflow = 3.08 cfs @ 12.37 hrs, Volume= 0.438 af, Atten= 0%, Lag= 0.0 min  
 Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

**Reach IP-2: PROP. LINE**

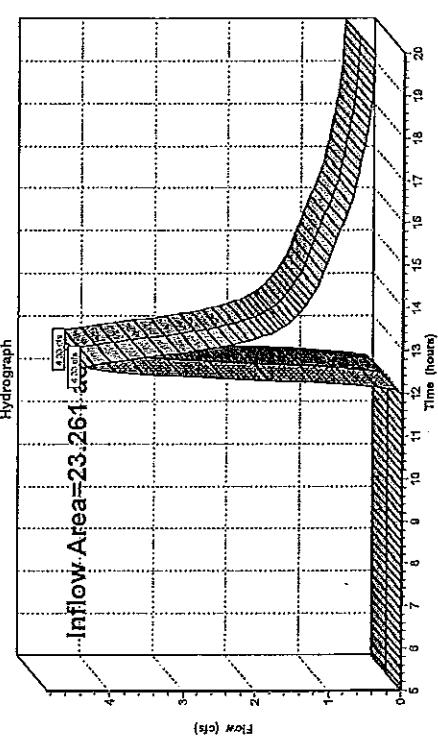


### Summary for Reach IP-3: WETLANDS

Inflow Area = 23.261 ac, 3.38% Impervious, Inflow Depth > 0.38" for 2YR event  
 Inflow = 4.33 cfs @ 12.62 hrs, Volume= 0.730 af  
 Outflow = 4.33 cfs @ 12.62 hrs, Volume= 0.730 af, Atten= 0%, Lag= 0.0 min

Routing by Sto+Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

### Reach IP-3: WETLANDS

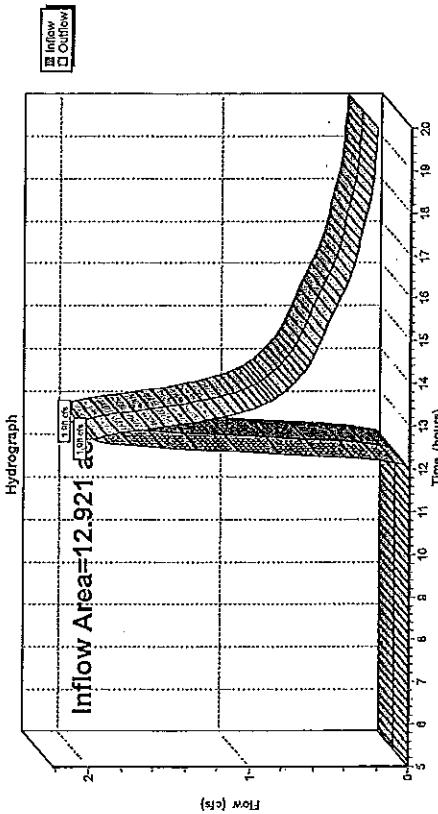


### Summary for Reach IP-4: PROP. LINE

Inflow Area = 12.921 ac, 2.13% Impervious, Inflow Depth > 0.34" for 2YR event  
 Inflow = 1.98 cfs @ 12.70 hrs, Volume= 0.369 af  
 Outflow = 1.98 cfs @ 12.70 hrs, Volume= 0.369 af, Atten= 0%, Lag= 0.0 min

Routing by Sto+Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

### Reach IP-4: PROP. LINE



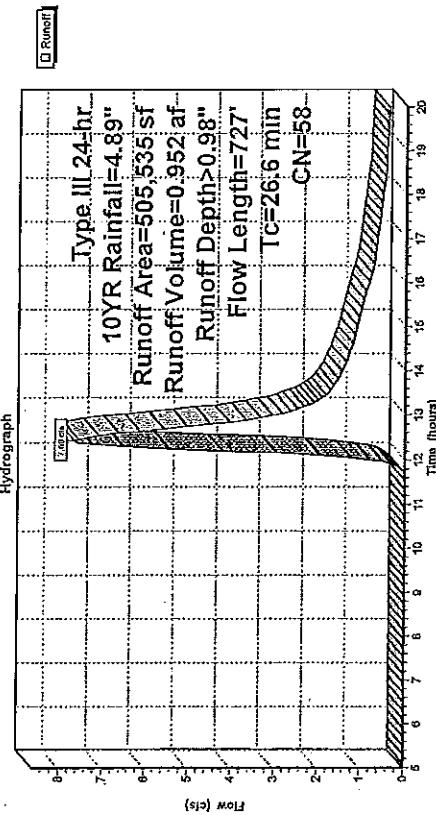
**PRE DEVELOPMENT**  
 Prepared by {enter your company name here}  
 HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 10YR Rainfall=4.89"  
 Printed 2/1/2017  
 Page 11

**Summary for Subcatchment 1E: DA 1E**

Runoff	=	7.69 cfs @ 12.44 hrs. Volume=	0.952 af, Depth> 0.98"		
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs					
Type III 24-hr 10YR Rainfall=4.89"					
Area (sf)	CN	Description			
496,983	58	Woods/grass comb., Good, HSG B			
8,552	82	Dirt roads, HSG B			
505,535	58	Weighted Average			
505,535	55	100.00% Pervious Area			
Tc	Length	Slope	Velocity	Capacity	Description
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	
12.3	50	0.0200	0.07	Sheet Flow, TRAVEL PATH A TO B	
				Woods: Light underbrush, r=0.400	P2=3.20"
				Shallow Concentrated Flow, TRAVEL PATH B TO C	
				Woodland Ky= 5.0 fps	
26.6	727	Total			

**Subcatchment 1E: DA 1E**



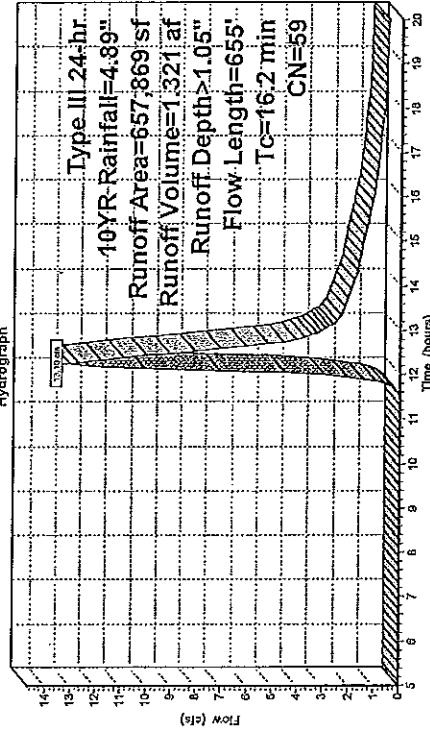
**PRE DEVELOPMENT**  
 Prepared by {enter your company name here}  
 HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 10YR Rainfall=4.89"  
 Printed 2/1/2017  
 Page 12

**Summary for Subcatchment 2E: DA 2E**

Runoff	=	13.10 cfs @ 12.26 hrs, Volume=	1.321 af, Depth> 1.05"		
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs					
Type III 24-hr 10YR Rainfall=4.89"					
Area (sf)	CN	Description			
625,843	58	Woods/grass comb., Good, HSG B			
32,026	82	Dirt roads, HSG B			
637,869	59	Weighted Average			
637,869	55	100.00% Pervious Area			
Tc	Length	Slope	Velocity	Capacity	Description
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	
9.9	30	0.0500	0.05	Sheet Flow, TRAVEL PATH A TO B	
				Woods: Dense underbrush, r= 0.800	P2=3.20"
				Shallow Concentrated Flow, TRAVEL PATH B TO C	
				Woodland Ky= 5.0 fps	
16.2	655	Total			

**Subcatchment 2E: DA 2E**



**PRE DEVELOPMENT**  
Prepared by [enter your company name here]  
HydroCAD® 10.00-16 s/n 01453 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 10YR Rainfall=4.89"  
Printed 2/1/2017  
Page 13  
Prepared by [enter your company name here]  
HydroCAD® 10.00-16 s/n 01453 © 2015 HydroCAD Software Solutions LLC

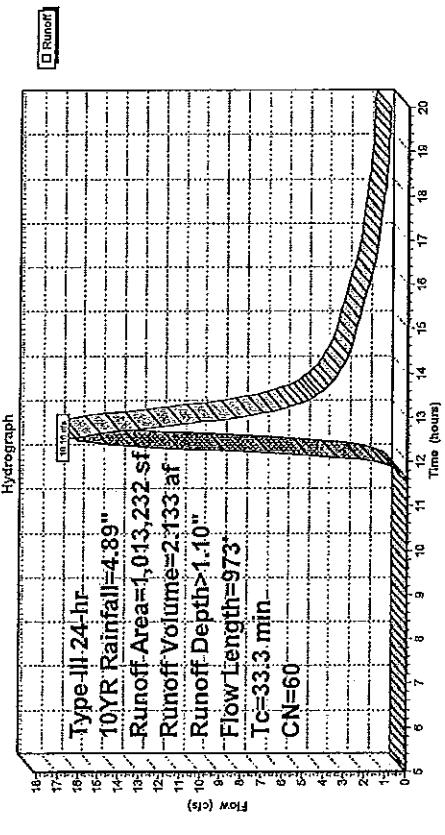
### Summary for Subcatchment 3E: DA 3E

Runoff = 16.16 cfs @ 12.53 hrs, Volume= 2,133 af, Depth> 1.10"  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs  
Type III 24-hr 10YR Rainfall=4.89"

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
21.5	50	0.0200	0.04	Sheet Flow, TRAVEL PATH A TO B Woods: Dense underbrush n= 0.800 P2= 3.20' Shallow Concentrated Flow, TRAVEL PATH B TO C Woodland Kv= 5.0 fps	
10.5	777	0.0610	1.23		
1.3	146	0.0360	1.90		
33.3	973	Total			Nearly Bare & Untilled Kv= 10.0 fps

### Subcatchment 3E: DA 3E

Hydrograph



### Summary for Subcatchment 4E: DA 4E

Runoff = 7.88 cfs @ 12.60 hrs, Volume= 1,117 af, Depth> 1.04"  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs  
Type III 24-hr 10YR Rainfall=4.89"

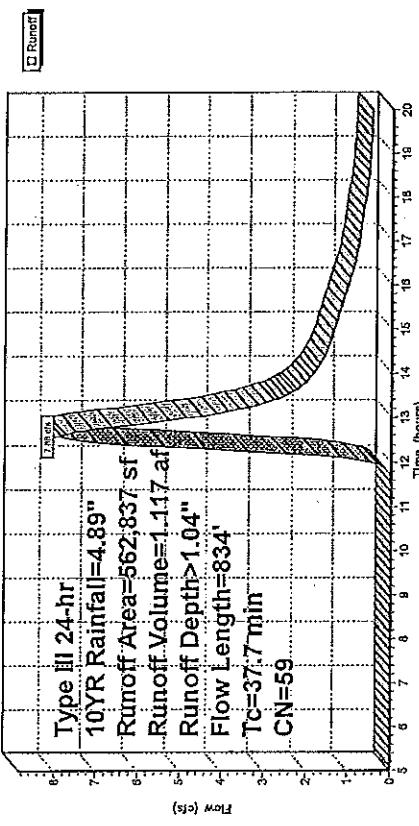
Area (sf)	CN	Description
532,837	58	Woods/grass comb., Good, HSG B
12,000	98	Water Surface, HSG B
18,000	61	>75% Grass cover, Good, HSG B
562,837	59	Weighted Average
550,837		97.87% Previous Area
12,000		2.13% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
28.3	50	0.0100	0.03	Sheet Flow, TRAVEL PATH A TO B	
					Woods: Dense underbrush n= 0.800 P2= 3.20'
					Shallow Concentrated Flow, TRAVEL PATH B TO C
					Woodland Kv= 5.0 fips
					Shallow Concentrated Flow, TRAVEL PATH C TO D
37.7	834	Total			Nearly Bare & Untilled Kv= 10.0 fps

### Subcatchment 4E: DA 4E

Hydrograph



**PRE DEVELOPMENT**  
 Prepared by {enter your company name here}  
 HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 10YR Rainfall=4.89"

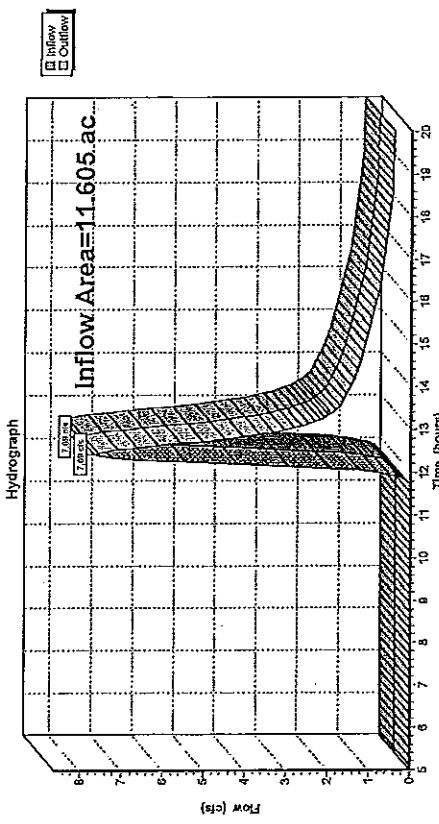
Printed 2/1/2017  
 Page 15

#### Summary for Reach IP-1: VERNAL POOL.

Inflow Area = 11.605 ac, 0.00% Impervious, Inflow Depth > 0.98" for 10YR event  
 Inflow = 7.69 cfs @ 12.44 hrs, Volume= 0.952 af  
 Outflow = 7.69 cfs @ 12.44 hrs, Volume= 0.952 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

#### Reach IP-1: VERNAL POOL



**PRE DEVELOPMENT**  
 Prepared by {enter your company name here}  
 HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC

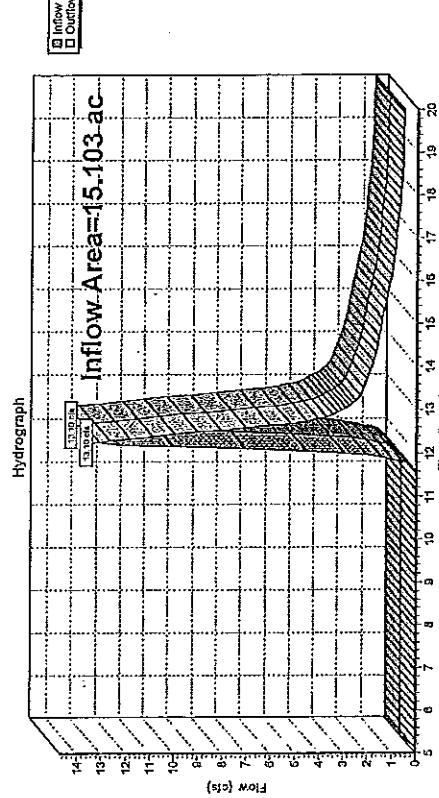
Type III 24-hr 10YR Rainfall=4.89"  
 Printed 2/1/2017  
 Page 16

#### Summary for Reach IP-2: PROP. LINE

Inflow Area = 15.103 ac, 0.00% Impervious, Inflow Depth > 1.05" for 10YR event  
 Inflow = 13.10 cfs @ 12.26 hrs, Volume= 1.321 af  
 Outflow = 13.10 cfs @ 12.26 hrs, Volume= 1.321 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

#### Reach IP-2: PROP. LINE



**PRE DEVELOPMENT**  
Prepared by {enter your company name here}  
HydroCAD® 10.00-16 sn 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 10YR Rainfall=4.89"  
Printed 2/1/2017  
Page 17

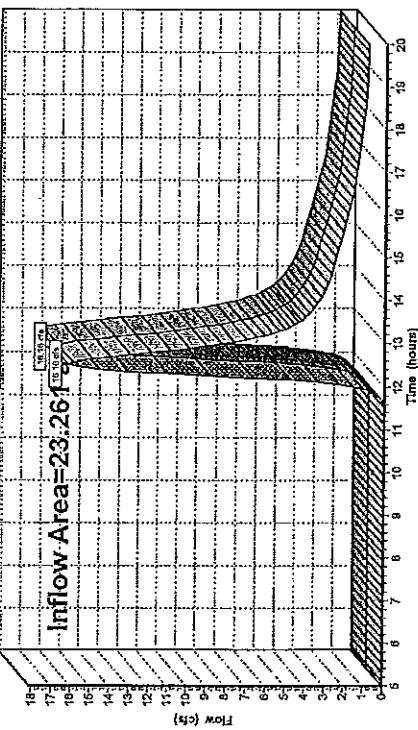
**Summary for Reach IP-3: WETLANDS**

Inflow Area = 23.261 ac, 3.38% Impervious, Inflow Depth > 1.10" for 10YR event  
Inflow = 16.16 cfs @ 12.53 hrs, Volume= 2.133 af  
Outflow = 16.16 cfs @ 12.53 hrs, Volume= 2.133 af, Atten= 0%, Lag= 0.0 min

Routing by StoI-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

**Reach IP-3: WETLANDS**

Hydrograph



**PRE DEVELOPMENT**  
Prepared by {enter your company name here}  
HydroCAD® 10.00-16 sn 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 10YR Rainfall=4.89"  
Printed 2/1/2017  
Page 18

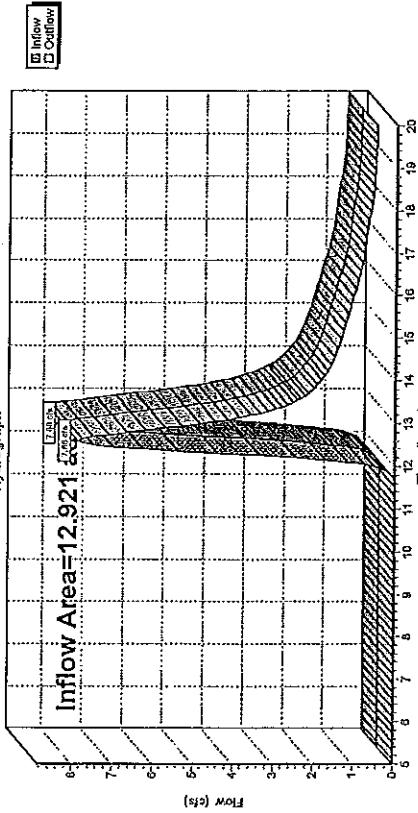
**Summary for Reach IP-4: PROP. LINE**

Inflow Area = 12.921 ac, 2.13% Impervious, Inflow Depth > 1.04" for 10YR event  
Inflow = 7.88 cfs @ 12.60 hrs, Volume= 1.117 af  
Outflow = 7.88 cfs @ 12.60 hrs, Volume= 1.117 af, Atten= 0%, Lag= 0.0 min

Routing by StoI-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

**Reach IP-4: PROP. LINE**

Hydrograph



**PRE DEVELOPMENT**  
Prepared by {enter your company name here}  
HydroCAD® 10.00-16 sn 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 25YR Rainfall=6.22"  
Printed 2/1/2017  
Page 19

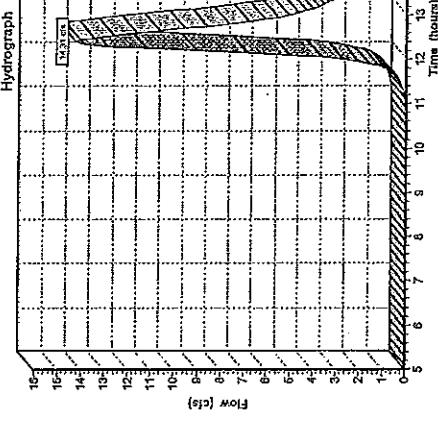
**PRE DEVELOPMENT**  
Prepared by {enter your company name here}  
HydroCAD® 10.00-16 sn 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 25YR Rainfall=6.22"  
Printed 2/1/2017  
Page 20

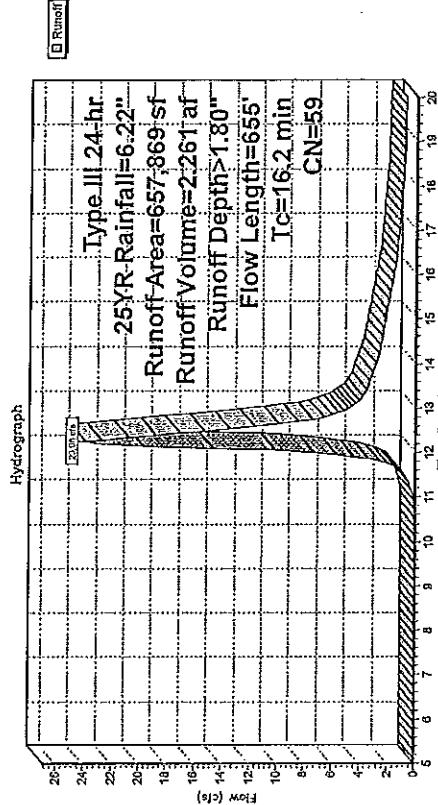
**Summary for Subcatchment 1E: DA 1E**

Runoff	=	14.31 cfs @ 12:41 hrs, Volume=	1,681 af, Depth> 1.71"
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs			
Type III 24-hr 25YR Rainfall=6.22"			
Area (sf)	CN	Description	
496,983	58	Woods/grass comb., Good, HSG B	
8,552	82	Dirt roads, HSG B	
505,535	58	Weighted Average	
505,535		100.00% Previous Area	
Tc	Length	Slope	Capacity
(min)	(feet)	(ft/ft)	(cfs)
12.3	50	0.0200	0.07
Sheet Flow, TRAVEL PATH A TO B			
Woods: Light underbrush n= 0.400 P2= 3.20"			
Shallow Concentrated Flow, TRAVEL PATH B TO C			
Woodland Kv= 5.0 fps			
26.6	727	Total	

**Subcatchment 1E: DA 1E**



**Subcatchment 2E: DA 2E**



**PRE DEVELOPMENT**  
Prepared by [enter your company name here]  
HydroCAD® 10.00-16 sn 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 25YR Rainfall=6.22"  
Printed 2/1/2017  
Page 21

**PRE DEVELOPMENT**  
Prepared by [enter your company name here]  
HydroCAD® 10.00-16 sn 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 25YR Rainfall=6.22"  
Printed 2/1/2017  
Page 22

### Summary for Subcatchment 3E: DA 3E

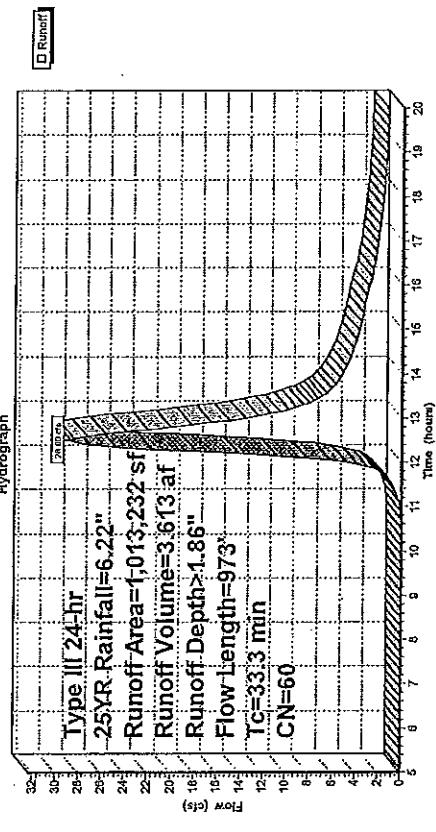
$$\text{Runoff} = 28.80 \text{ cfs} @ 12.50 \text{ hrs, Volume=} 3.613 \text{ af, Depth} > 1.86"$$

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs  
Type III 24-hr 25YR Rainfall=6.22"

Area (sf)	CN	Description
692,386	58	Woods/grass comb, Good, HSG B
34,219	98	Paved parking & roofs
285,077	61	>75% Grass cover, Good, HSG B
1,013,232	60	Weighted Average
979,013	96.62%	Pervious Area
34,219	3.38%	Impervious Area
<b>Total</b>		
33.3	973	Total

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
21.5	50	0.0200	0.04	Sheet Flow, TRAVEL PATH A TO B	
				Woods: Dense underbrush n= 0.800 P2= 3.20"	
10.5	777	0.0510	1.23	Shallow Concentrated Flow, TRAVEL PATH B TO C	
1.3	146	0.0360	1.90	Woodland Kv= 5.0 fps	
				Shallow Concentrated Flow, TRAVEL PATH C TO D	
				Nearby Bare & Untilled Kv= 10.0 fps	
<b>Total</b>					
33.3	973	Total			

### Subcatchment 3E: DA 3E



### Summary for Subcatchment 4E: DA 4E

$$\text{Runoff} = 14.32 \text{ cfs} @ 12.57 \text{ hrs, Volume=} 1.915 \text{ af, Depth} > 1.78"$$

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs  
Type III 24-hr 25YR Rainfall=6.22"

Area (sf)	CN	Description
532,837	58	Woods/grass comb, Good, HSG B
12,000	98	Water Surface, HSG B
18,000	61	>75% Grass cover, Good, HSG B
532,837	59	Weighted Average
550,837	97.87%	Pervious Area
<b>Total</b>		
12,000		2.13% Impervious Area

### Subcatchment 4E: DA 4E

$$\text{Runoff} = 1.915 \text{ af, Depth} > 1.78"$$

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs  
Type III 24-hr 25YR Rainfall=6.22"

Area (sf)	CN	Description
532,837	58	Woods/grass comb, Good, HSG B
12,000	98	Water Surface, HSG B
18,000	61	>75% Grass cover, Good, HSG B
532,837	59	Weighted Average
550,837	97.87%	Pervious Area
<b>Total</b>		
12,000		2.13% Impervious Area

### Subcatchment 4E: DA 4E

$$\text{Runoff} = 1.915 \text{ af, Depth} > 1.78"$$

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs  
Type III 24-hr 25YR Rainfall=6.22"

Area (sf)	CN	Description
532,837	58	Woods/grass comb, Good, HSG B
12,000	98	Water Surface, HSG B
18,000	61	>75% Grass cover, Good, HSG B
532,837	59	Weighted Average
550,837	97.87%	Pervious Area
<b>Total</b>		
12,000		2.13% Impervious Area

**PRE DEVELOPMENT**  
 Prepared by {enter your company name here}  
 HydroCAD® 10.00-16 sn 01433 © 2015 HydroCAD Software Solutions LLC  
 Type III 24-hr 25YR Rainfall=6.22"  
 Printed 2/1/2017  
 Page 23

Type III 24-hr 25YR Rainfall=6.22"  
 Prepared by {enter your company name here}  
 HydroCAD® 10.00-16 sn 01433 © 2015 HydroCAD Software Solutions LLC  
 Page 24

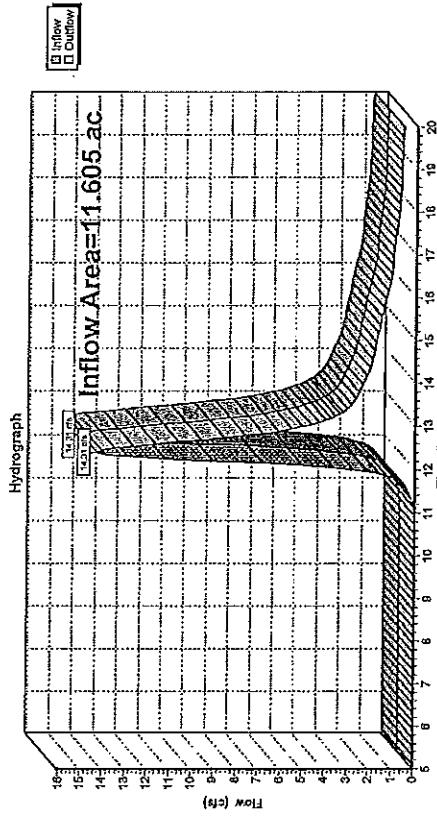
Type III 24-hr 25YR Rainfall=6.22"  
 Prepared by {enter your company name here}  
 HydroCAD® 10.00-16 sn 01433 © 2015 HydroCAD Software Solutions LLC  
 Page 24

**Summary for Reach IP-1: VERNAL POOL**

Inflow Area = 11.605 ac, 0.00% Impervious, Inflow Depth > 1.71" for 25YR event  
 Inflow = 14.31 cfs @ 12.41 hrs, Volume= 1.651 af  
 Outflow = 14.31 cfs @ 12.41 hrs, Volume= 1.651 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5:00-20:00 hrs, dt= 0.05 hrs

**Reach IP-1: VERNAL POOL**

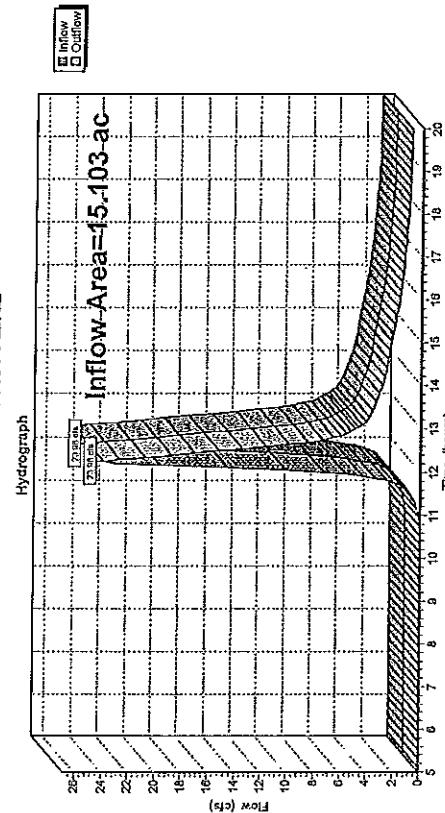


**Summary for Reach IP-2: PROP. LINE**

Inflow Area = 15.103 ac, 0.00% Impervious, Inflow Depth > 1.80" for 25YR event  
 Inflow = 23.98 cfs @ 12.25 hrs, Volume= 2.261 af  
 Outflow = 23.98 cfs @ 12.25 hrs, Volume= 2.261 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5:00-20:00 hrs, dt= 0.05 hrs

**Reach IP-2: PROP. LINE**



**PRE DEVELOPMENT**  
Prepared by {enter your company name here}  
HydroCAD® 10.00-16 sin 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 25YR Rainfall=6.22"  
Printed 2/1/2017  
Page 25

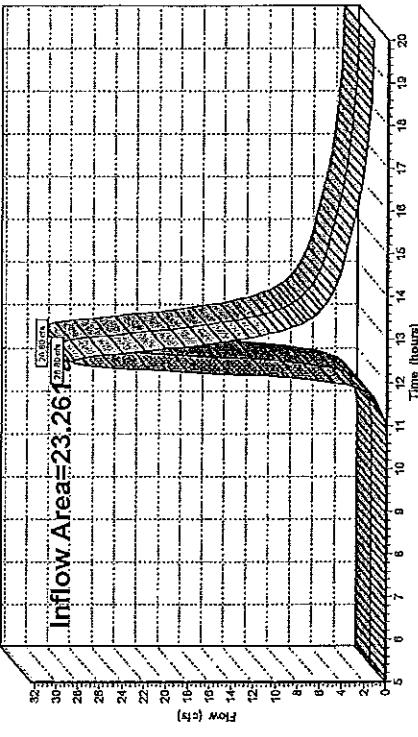
#### Summary for Reach IP-3: WETLANDS

Inflow Area = 23.261 ac, 3.38% Impervious, Inflow Depth > 1.86" for 25YR event  
Inflow = 28.80 cfs @ 12.50 hrs, Volume= 3.613 af  
Outflow = 28.80 cfs @ 12.50 hrs, Volume= 3.613 af, Atten= 0%, Lag= 0.0 min

Routing by StoR-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

#### Reach IP-3: WETLANDS

Hydrograph



**PRE DEVELOPMENT**  
Prepared by {enter your company name here}  
HydroCAD® 10.00-16 sin 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 25YR Rainfall=6.22"  
Printed 2/1/2017  
Page 26

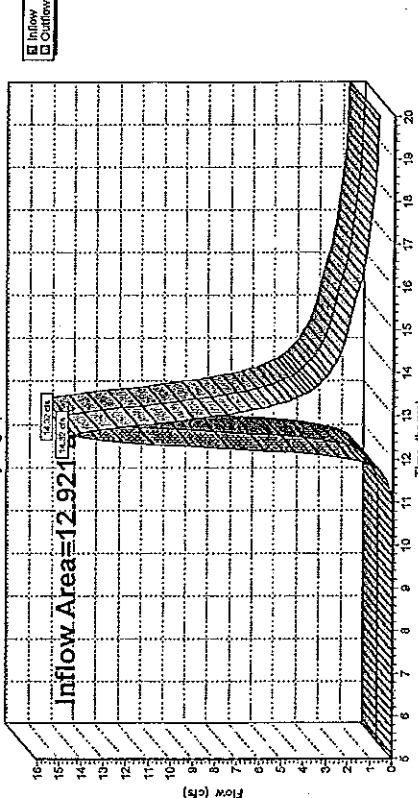
#### Summary for Reach IP-4: PROP. LINE

Inflow Area = 12.921 ac, 2.13% Impervious, Inflow Depth > 1.78" for 25YR event  
Inflow = 14.32 cfs @ 12.57 hrs, Volume= 1.915 af  
Outflow = 14.32 cfs @ 12.57 hrs, Volume= 1.915 af, Atten= 0%, Lag= 0.0 min

Routing by StoR-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

#### Reach IP-4: PROP. LINE

Hydrograph



**PRE DEVELOPMENT**  
 Prepared by {enter your company name here}  
 HydroCAD® 10.00-16 sn 01433 © 2015 HydroCAD Software Solutions LLC

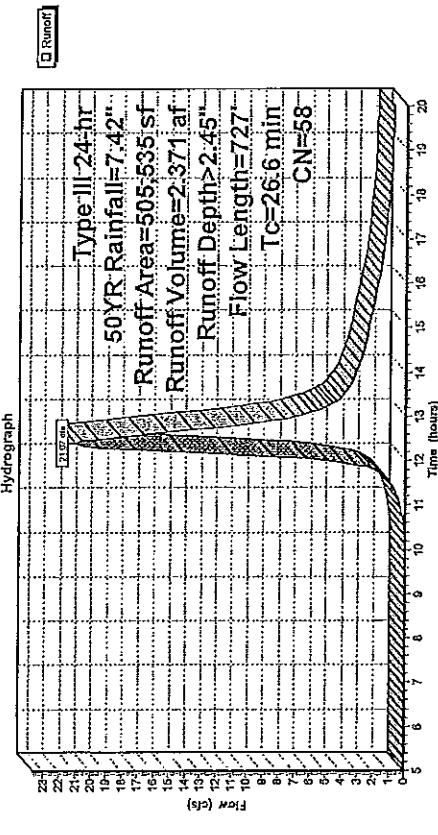
Type III 24-hr 50YR Rainfall=7.42"  
 Printed 2/1/2017  
 Page 27

**Summary for Subcatchment 1E: DA 1E**

Runoff = 21.07 cfs @ 12.40 hrs, Volume= 2,371 af, Depth> 2.45"  
 Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 50YR Rainfall=7.42"

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	50	0.0200	0.07	Sheet Flow, TRAVEL PATH A TO B Woods: Light underbrush n= 0.400 P2= 3.20"	
14.3	677	0.0250	0.79	Shallow Concentrated Flow, TRAVEL PATH B TO C Woodland Kv= 5.0 f/s	
26.6	727	Total			

**Subcatchment 1E: DA 1E**



**PRE DEVELOPMENT**  
 Prepared by {enter your company name here}  
 HydroCAD® 10.00-16 sn 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 50YR Rainfall=7.42"  
 Printed 2/1/2017  
 Page 28

**Summary for Subcatchment 2E: DA 2E**

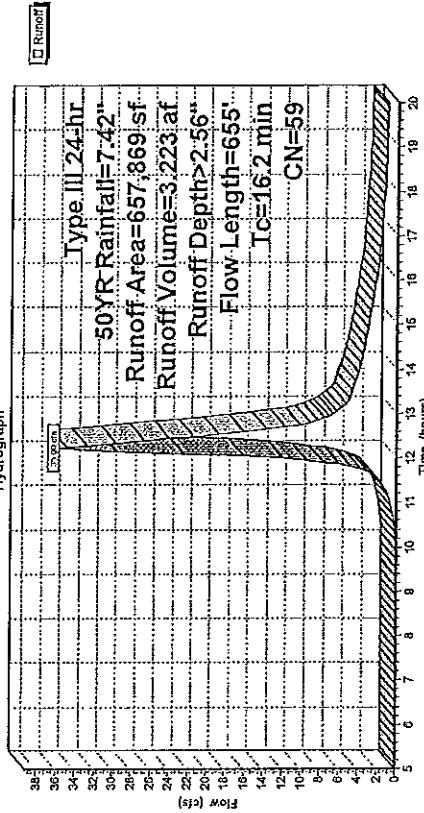
Runoff = 35.00 cfs @ 12.24 hrs, Volume= 3,223 af, Depth> 2.56"  
 Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 50YR Rainfall=7.42"

Area (sf)	CN	Description
625.843	58	Woods/grass comb., Good, HSG B
32.026	82	Dirt roads, HSG B
657.869	59	Weighted Average
657.869	59	100.00% Perious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.9	30	0.0500	0.05	Sheet Flow, TRAVEL PATH A TO B Woods: Dense underbrush n= 0.800 P2= 3.20"	
6.3	625	0.1100	1.66	Shallow Concentrated Flow, TRAVEL PATH B TO C Woodland Kv= 5.0 f/s	
16.2	655	Total			

**Subcatchment 2E: DA 2E**



### Summary for Subcatchment 3E: DA 3E

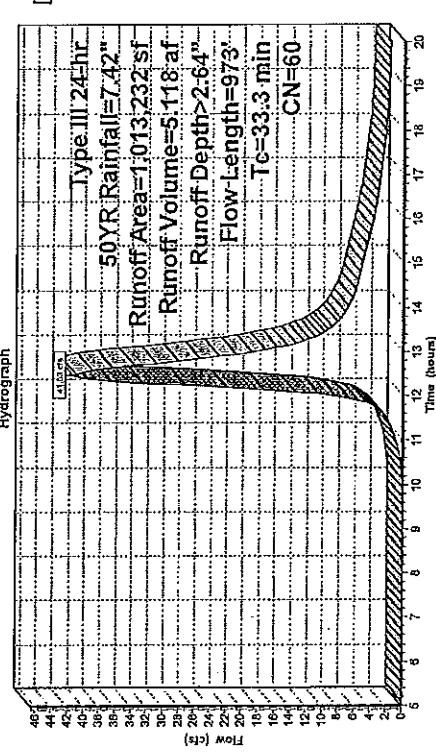
Runoff = 41.53 cfs @ 12.49 hrs, Volume= 5.118 af, Depth> 2.64"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 50YR Rainfall=7.42"

Area (sf)	CN	Description
692,936	58	Woods/grass comb, Good, HSG B
34,218	98	Paved parking & roofs
286,077	61	>75% Grass cover, Good, HSG B
1,013,232	60	Weighted Average
979,013	96.62%	Pervious Area
34,219	3.38%	Impervious Area
33.3	Total	

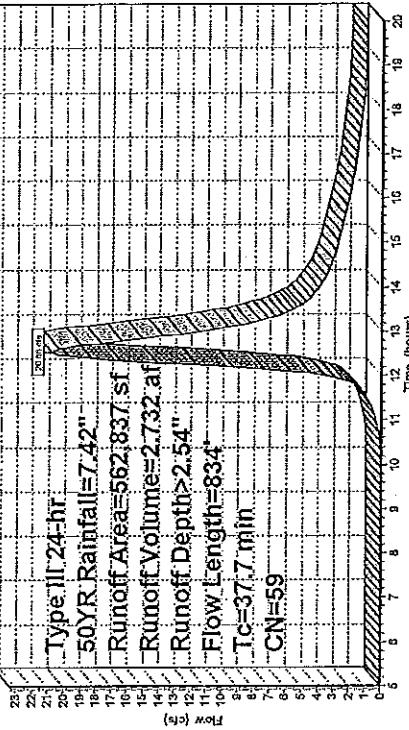
Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
21.5	50	0.02010	0.04	Sheet Flow, TRAVEL PATH A TO B	
				Woods: Dense underbrush n= 0.800 P2= 3.20"	
10.5	777	0.0610	1.23	Shallow Concentrated Flow, TRAVEL PATH B TO C	
				Woodland Kv= 5.0 fps	
1.3	146	0.0360	1.90	Shallow Concentrated Flow, TRAVEL PATH C TO D	
				Nearly Bare & Untilled Kv= 10.0 fps	
33.3	973	Total			

### Subcatchment 3E: DA 3E



### Subcatchment 4E: DA 4E

Hydrograph



### Summary for Subcatchment 4E: DA 4E

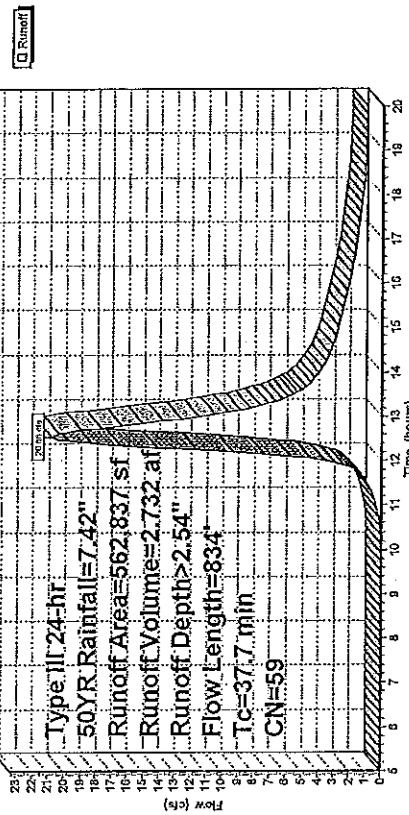
Runoff = 20.86 cfs @ 12.55 hrs, Volume= 2.732 af, Depth> 2.54"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 50YR Rainfall=7.42"

Area (sf)	CN	Description
532,837	58	Woods/grass comb, Good, HSG B
12,000	98	Water Surface, HSG B
18,000	61	>75% Grass cover, Good, HSG B
562,837	59	Weighted Average
550,837	97.87%	Previous Area
12,000	2.13%	Impervious Area
37.7	Total	

### Subcatchment 4E: DA 4E

Hydrograph



**PRE DEVELOPMENT**  
 Prepared by {enter your company name here}  
 HydroCAD® 10.00-16 sn 01433 © 2015 HydroCAD Software Solutions LLC

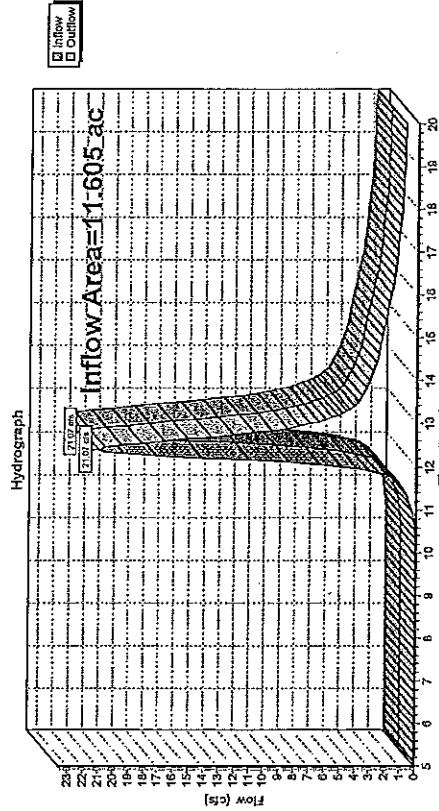
Type III 24-hr 50YR Rainfall=7.42"  
 Printed 2/1/2017  
 Page 31

**PRE DEVELOPMENT**  
 Prepared by {enter your company name here}  
 HydroCAD® 10.00-16 sn 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 50YR Rainfall=7.42"  
 Printed 2/1/2017  
 Page 32

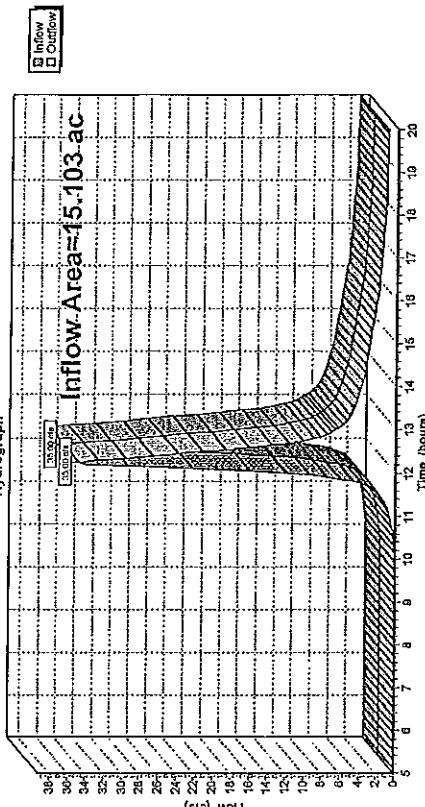
Inflow Area = 11.605 ac, 0.00% Impervious, Inflow Depth > 2.45" for 50YR event  
 Inflow = 21.07 cfs @ 12.40 hrs, Volume= 2.371 af  
 Outflow = 21.07 cfs @ 12.40 hrs, Volume= 2.371 af, Atten= 0%, Lag= 0.0 min  
 Routing by Sto-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

**Reach IP-1: VERNAL POOL**

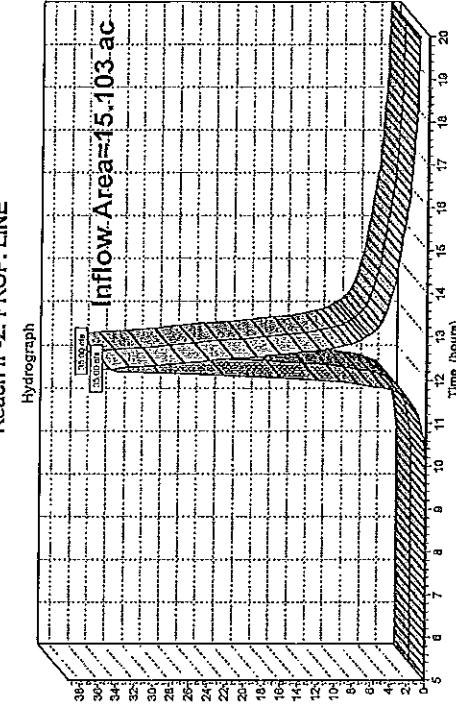


Inflow Area = 15.103 ac, 0.00% Impervious, Inflow Depth > 2.56" for 50YR event  
 Inflow = 35.00 cfs @ 12.24 hrs, Volume= 3.223 af  
 Outflow = 35.00 cfs @ 12.24 hrs, Volume= 3.223 af, Atten= 0%, Lag= 0.0 min  
 Routing by Sto-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

**Summary for Reach IP-2: PROP. LINE**



**Reach IP-2: PROP. LINE**



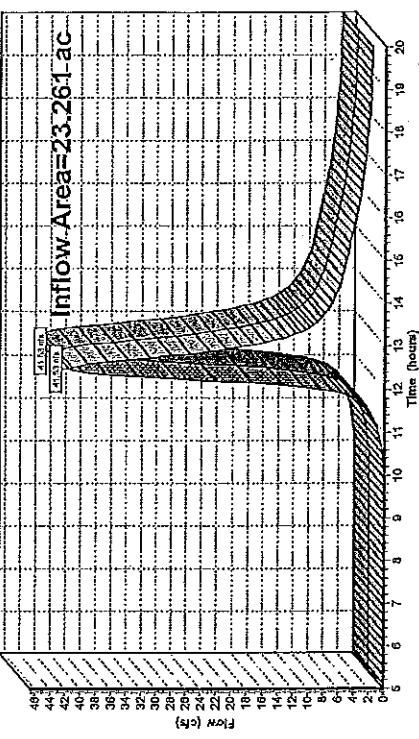
#### Summary for Reach IP-3: WETLANDS

Inflow Area = 23.261 ac, 3.38% Impervious, Inflow Depth > 2.64" for 50YR event  
 Inflow = 41.55 cfs @ 12.49 hrs, Volume= 5.118 af, Atten= 0%, Lag= 0.0 min  
 Outflow = 41.53 cfs @ 12.49 hrs, Volume= 5.118 af

Routing by StoR-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

#### Reach IP-3: WETLANDS

Hydrograph



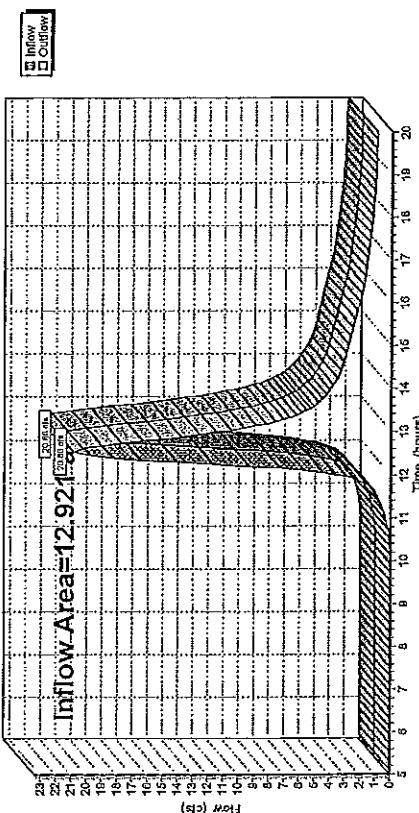
#### Summary for Reach IP-4: PROP. LINE

Inflow Area = 12.921 ac, 2.13% Impervious, Inflow Depth > 2.54" for 50YR event  
 Inflow = 20.86 cfs @ 12.55 hrs, Volume= 2.732 af  
 Outflow = 20.86 cfs @ 12.55 hrs, Volume= 2.732 af, Atten= 0%, Lag= 0.0 min

Routing by StoR-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

#### Reach IP-4: PROP. LINE

Hydrograph



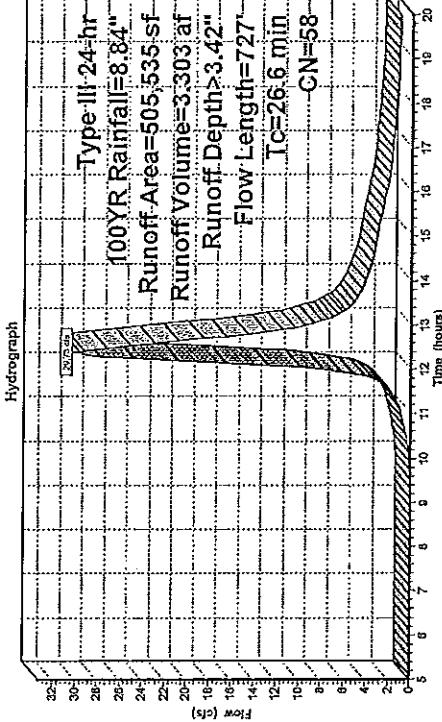
**PRE DEVELOPMENT**  
 Prepared by {enter your company name here}  
 HydroCAD® 10.00-16 sn 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 100YR Rainfall=8.84"  
 Printed 2/1/2017  
 Page 35

**Summary for Subcatchment 1E: DA 1E**

Runoff	=	29.73 cfs @ 12.39 hrs, Volume= 3,303 af, Depth> 3.42"			
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs					
Type III 24-hr 100YR Rainfall=8.84"					
Area (sf)	CN	Description			
496,983	58	Woods/grass comb., Good, HSG B			
8,552	82	Dirt roads, HSG B			
505,535	58	Weighted Average			
505,535		100.00% PerVIOUS Area			
Tc	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	50	0.0220	0.07	Sheet Flow, TRAVEL PATH A TO B Woods: Light underbrush n= 0.400 P2= 3.20"	
14.3	677	0.0250	0.79	Shallow Concentrated Flow, TRAVEL PATH B TO C Woodland Kv= 5.0 fps	
26.6	727	Total			

**Subcatchment 1E: DA 1E**



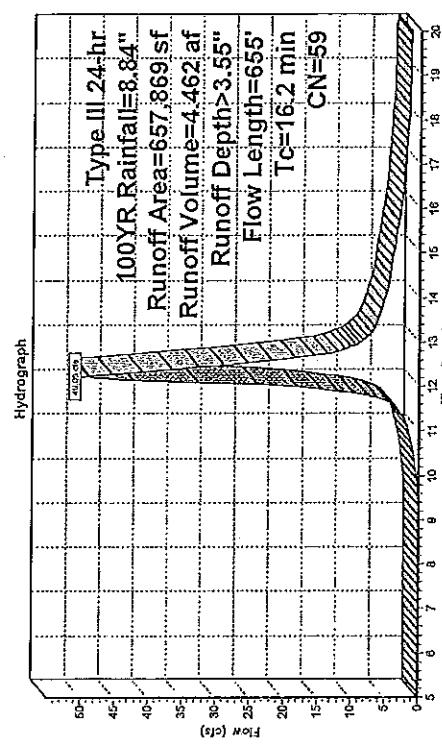
**PRE DEVELOPMENT**  
 Prepared by {enter your company name here}  
 HydroCAD® 10.00-16 sn 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 100YR Rainfall=8.84"  
 Printed 2/1/2017  
 Page 35

**Summary for Subcatchment 2E: DA 2E**

Runoff	=	49.05 cfs @ 12.23 hrs, Volume= 4,462 af, Depth> 3.55"			
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs					
Type III 24-hr 100YR Rainfall=8.84"					
Area (sf)	CN	Description			
625,843	58	Woods/grass comb., Good, HSG B			
32,026	82	Dirt roads, HSG B			
657,889	59	Weighted Average			
657,889		100.00% PerVIOUS Area			
Tc	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.9	30	0.0500	0.05	Sheet Flow, TRAVEL PATH A TO B Woods: Dense underbrush n= 0.800 P2= 3.20"	
6.3	625	0.1100	1.66	Shallow Concentrated Flow, TRAVEL PATH B TO C Woodland Kv= 5.0 fps	
16.2	655	Total			

**Subcatchment 2E: DA 2E**



**PRE DEVELOPMENT**  
 Prepared by {enter your company name here}  
 HydroCAD® 10.0c-16 sn.01433 © 2015 HydroCAD Software Solutions LLC

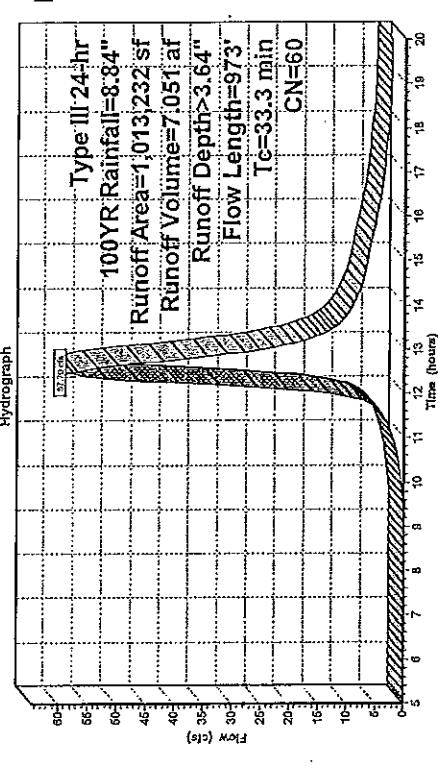
Type III 24-hr 100YR Rainfall=8.84"  
 Printed 2/1/2017  
 Page 37

#### Summary for Subcatchment 3E: DA 3E

Runoff	=	57.70 cfs @ 12.48 hrs, Volume=	7.051 af, Depth> 3.64"
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs			
Type III 24-hr 100YR Rainfall=8.84"			
Area (sf)	CN	Description	
692,936	58	Woods/grass comb., Good, HSG: B	
34,219	98	Paved parking & roofs	
286,077	61	>75% Grass cover, Good, HSG: B	
1,013,232	60	Weighted Average	
979,013	96.62%	Nearly Bare & Unutilized Area	
34,219	3.38%	Impervious Area	
Tc	Length	Slope	Velocity
(min)	(feet)	(ft/sec)	(ft/sec)
21.5	50	0.0200	0.04
10.5	777	0.0610	1.23
1.3	146	0.0360	1.90
33.3	973	Total	

Tc	Length	Slope	Velocity	Capacity	Description
(min)	(feet)	(ft/sec)	(ft/sec)	(cfs)	
21.5	50	0.0200	0.04	Sheet Flow, TRAVEL PATH A TO B	
				Woods: Dense underbrush n= 0.800 P2= 3.20"	
				Shallow Concentrated Flow, TRAVEL PATH B TO C	
				Woodland Ku= 5.0 fps	
				Shallow Concentrated Flow, TRAVEL PATH C TO D	
				Nearly Bare & Unutilized Kv= 10.0 fps	

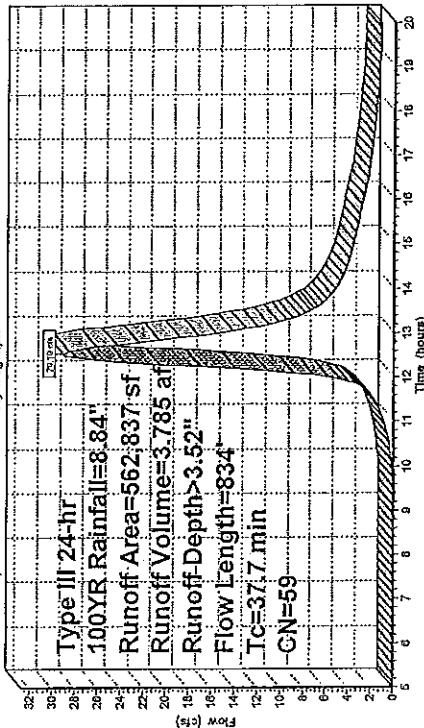
#### Subcatchment 3E: DA 3E



#### Summary for Subcatchment 4E: DA 4E

Runoff	=	29.19 cfs @ 12.54 hrs, Volume=	3.785 af, Depth> 3.52"
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs			
Type III 24-hr 100YR Rainfall=8.84"			
Area (sf)	CN	Description	
552,837	58	Woods/grass comb., Good, HSG: B	
12,000	98	Water Surface, HSG: B	
18,000	61	>75% Grass cover, Good, HSG: B	
562,837	59	Weighted Average	
550,837	59	97.8% Pervious Area	
12,000		2.13% Impervious Area	
Tc	Length	Slope	Velocity
(min)	(feet)	(ft/ft)	(ft/sec)
28.3	50	0.0100	0.03

#### Subcatchment 4E: DA 4E



**PRE DEVELOPMENT**  
 Prepared by {enter your company name here}  
 HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 100YR Rainfall=8.84"  
 Printed 2/1/2017  
 Page 39

**PRE DEVELOPMENT**  
 Prepared by {enter your company name here}  
 HydroCAD@ 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 100YR Rainfall=8.84"  
 Printed 2/1/2017  
 Page 40

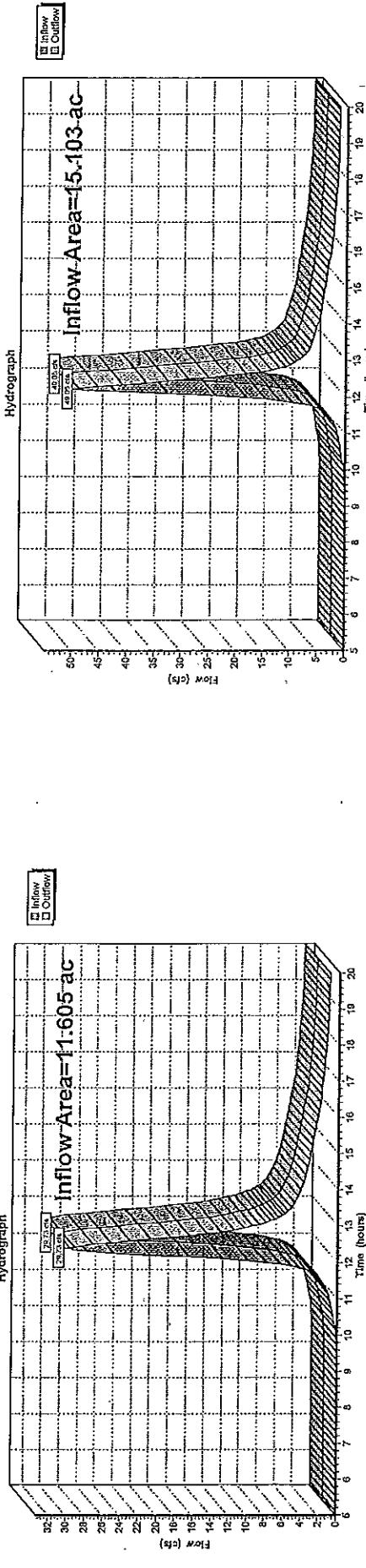
**Summary for Reach IP-1: VERNAL POOL**

Inflow Area = 11.505 ac, 0.00% Impervious, Inflow Depth > 3.42" for 100YR event  
 Inflow = 29.73 cfs @ 12.39 hrs, Volume= 3.303 af  
 Outflow = 29.73 cfs @ 12.39 hrs, Volume= 3.303 af, Attenu= 0%, Lag= 0.0 min

Routing by Star-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

**Reach IP-1: VERNAL POOL**

Hydrograph



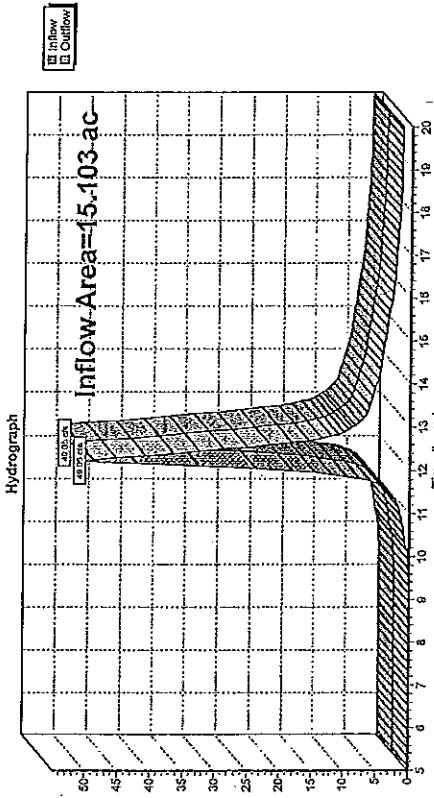
**Summary for Reach IP-2: PROP. LINE**

Inflow Area = 15.103 ac, 0.00% Impervious, Inflow Depth > 3.55" for 100YR event  
 Inflow = 49.05 cfs @ 12.23 hrs, Volume= 4.462 af  
 Outflow = 49.05 cfs @ 12.23 hrs, Volume= 4.462 af, Attenu= 0%, Lag= 0.0 min

Routing by Star-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

**Reach IP-2: PROP. LINE**

Hydrograph

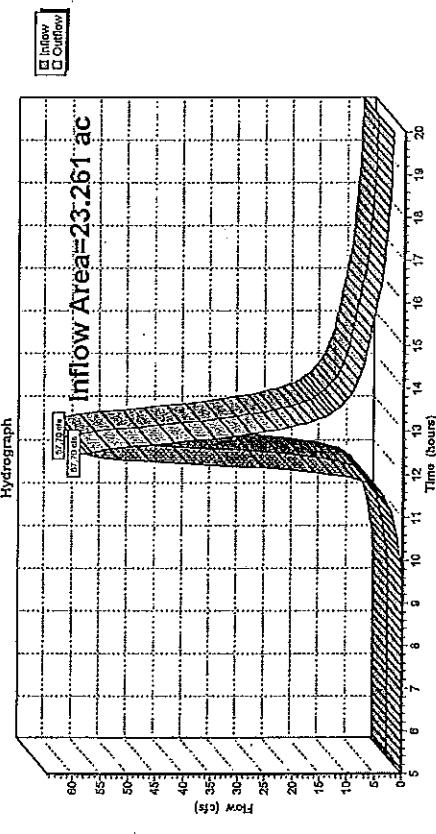


### Summary for Reach IP-3: WETLANDS

Inflow Area = 23.261 ac, 3.38% Impervious, Inflow Depth > 3.64" for 100YR event  
 Inflow = 57.70 cfs @ 12.48 hrs, Volume= 7.051 ac  
 Outflow = 57.70 cfs @ 12.48 hrs, Volume= 7.051 ac, Atten= 0%, Lag= 0.0 min

Routing by StoInd+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

### Reach IP-3: WETLANDS

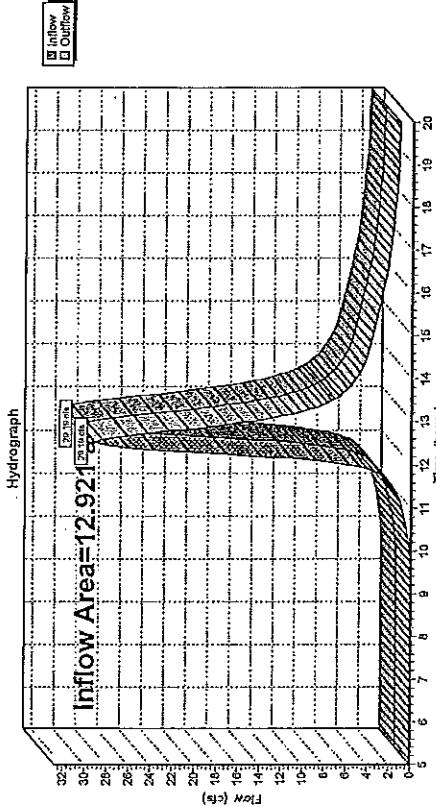


### Summary for Reach IP-4: PROP. LINE

Inflow Area = 12.921 ac, 2.13% Impervious, Inflow Depth > 3.52" for 100YR event  
 Inflow = 29.19 cfs @ 12.54 hrs, Volume= 3.785 ac  
 Outflow = 29.19 cfs @ 12.54 hrs, Volume= 3.785 ac, Atten= 0%, Lag= 0.0 min

Routing by StoInd+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

### Reach IP-4: PROP. LINE



## ***DRAINAGE ANALYSIS***

HydroCAD Calculations – Proposed Conditions

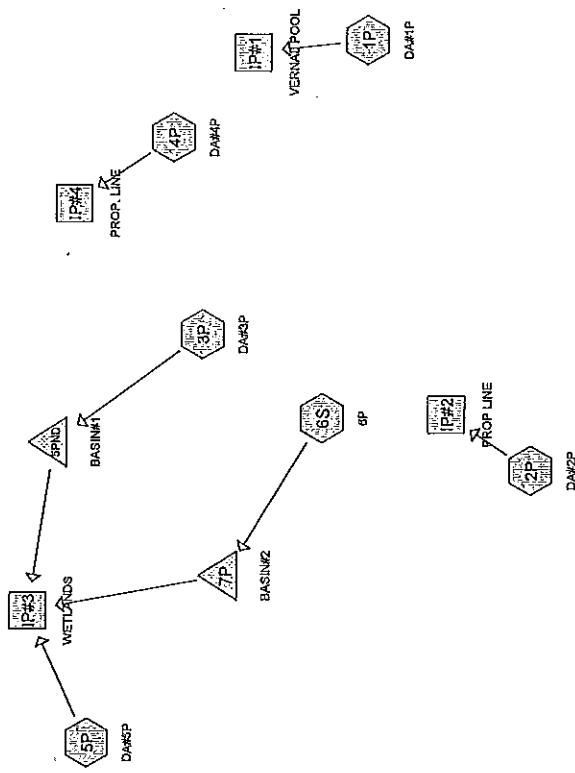
## post development 1-17

Prepared by {enter your company name here}  
 HydroCAD® 10.00-16 sn:01433 © 2015 HydroCAD Software Solutions LLC

Printed 2/1/2017  
 Page 2

## Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
18.328	61	>75% Grass cover, Good, HSG B (1P, 2P, 3P, 4P, 5P, 6S)
4.462	98	Paved parking & roofs (1P, 2P, 3P, 4P)
0.786	98	Paved parking, HSG A (5P)
1.125	98	Water Surface, HSG B (6S)
24.807	55	Woods, Good, HSG B (1P, 3P, 5P, 6S)
10.306	58	Woods/grass comb, Good, HSG B (2P, 4P)

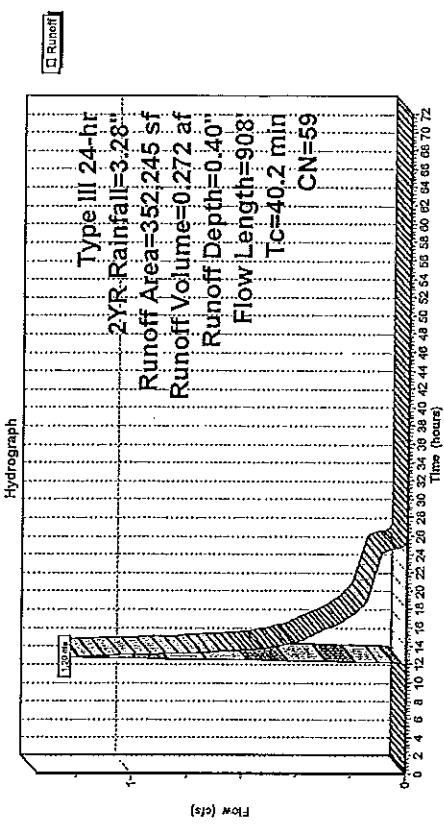


Routing Diagram for post development 1-17  
 Prepared by {enter your company name here}, Printed 2/1/2017  
 HydroCAD® 10.00-16 sn:01433 © 2015 HydroCAD Software Solutions LLC

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)	Runoff =	1.20 cfs @ 12.74 hrs, Volume=	0.272 ac, Depth= 0.40"
1	1P	0.00	0.00	100.0	0.0150	0.012	12.0	0.0	0.0	Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs	Type III 24-hr 2YR Rainfall=3.28"	
2	6S	0.00	0.00	283.0	0.0500	0.011	12.0	0.0	0.0	Area (sf)	CN Description	
										24,004	98 Paved parking & roofs	
										80,175	61 >75% Grass cover, Good, HSG B	
										248,066	55 Woods, Good, HSG B	
										352,245	59 Weighted Average	
										328,241	93.19% Pervious Area	
										24,004	6.81% Impervious Area	
										Tc	Length	Slope
										(min)	(feet)	(ft/ft)
												(ft/sec)
												(cfs)
										28.3	50 0.0100	0.03 Sheet Flow, TRAVEL PATH A TO B
												Woods: Dense underbrush n= 0.800 P2= 3.20°
										7.2	409 0.0360	0.95 Shallow Concentrated Flow, TRAVEL PATH B TO C
												Woodland Kv= 5.0 fps
										1.3	140 0.0150	1.84 Shallow Concentrated Flow, TRAVEL PATH C TO D
												Grassed Waterway Kv= 15.0 fps
										0.3	100 0.0150	6.02 Pipe Channel, TRAVEL PATH D TO E
												12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'
										0.8	89 0.0150	1.84 n= 0.012 Concrete pipe, finished
												Shallow Concentrated Flow, TRAVEL PATH E TO F
										2.3	120 0.0300	0.87 Grassed Waterway Kv= 15.0 fps
												Shallow Concentrated Flow, TRAVEL PATH F TO G
												Woodland Kv= 5.0 fps
										40.2	908 Total	

### Subcatchment 1P: DA#1P



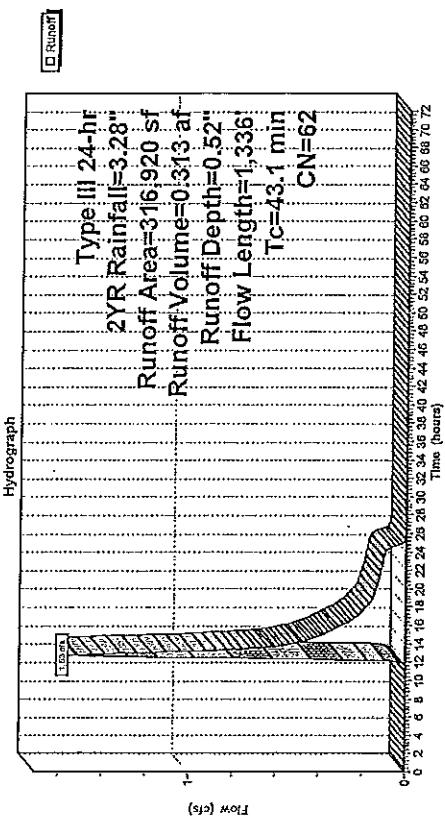
### Summary for Subcatchment 2P: DA#2P

Runoff = 1.53 cfs @ 12.74 hrs, Volume= 0.313 af, Depth= 0.52"  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, d= 0.05 hrs  
Type III 24-hr 2YR Rainfall=3.28"

Area (sf)	CN	Description			
23,199	98	Paved parking & roofs			
127,802	61	>75% Grass cover, Good, HSG B			
165,919	58	Woods/grass comb., Good, HSG B			
316,920	62	Weighted Average			
293,721		92.68% Pervious Area			
23,199		7.32% Impervious Area			
Tc	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
28.3	50	0.0100	0.03		Sheet Flow, TRAVEL PATH A TO B
					Woods, Dense underbrush n= 0.800 P2= 3.20"
					Shallow Concentrated Flow, TRAVEL PATH B TO C
					Woodland Kv= 5.0 ips
					Shallow Concentrated Flow, TRAVEL PATH C TO D
					Unpaved Kv= 16.1 ips
					Shallow Concentrated Flow, TRAVEL PATH D TO E
					Woodland Kv= 5.0 ips

43.1 1,336 Total

### Subcatchment 2P: DA#2P



**post development 1-17**  
 Prepared by {enter your company name here}  
 HydroCAD® 10.00-16 sn 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 2YR Rainfall=3.28"  
 Printed 2/1/2017  
 Page 7

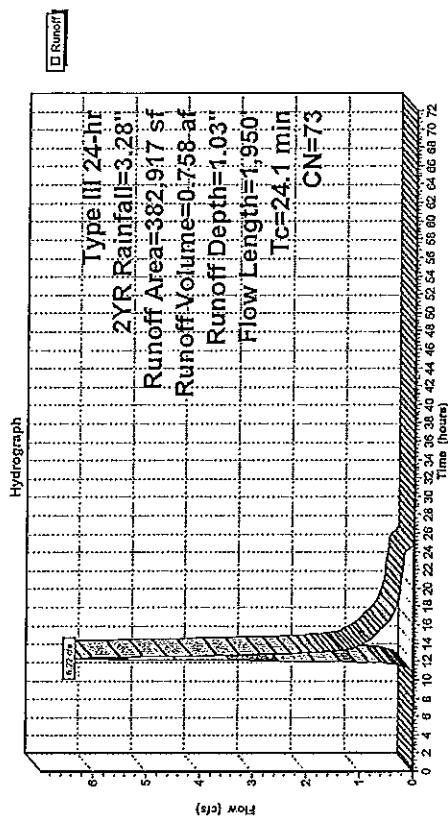
**Summary for Subcatchment 3P: DA#3P**

$$\text{Runoff} = 6.22 \text{ cfs} @ 12:37 \text{ hrs, Volume=} 0.758 \text{ af, Depth=} 1.03"$$

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 2YR Rainfall=3.28"

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.3	50	0.0400	0.05	Sheet Flow, TRAVEL PATH A TO B	
				Woods: Dense Underbrush n= 0.800 P2= 3.20"	
0.8	200	0.0600	3.94	Shallow Concentrated Flow, TRAVEL PATH B TO C	
				Unpaved Kv= 16.1 fps	
7.0	1,700	0.0400	4.06	Shallow Concentrated Flow, TRAVEL PATH C TO D	
				Paved Kv= 20.3 fps	
24.1	1,950	Total			

**Subcatchment 3P: DA#3P**



**post development 1-17**  
 Prepared by {enter your company name here}  
 HydroCAD® 10.00-16 sn 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 2YR Rainfall=3.28"  
 Printed 2/1/2017  
 Page 8

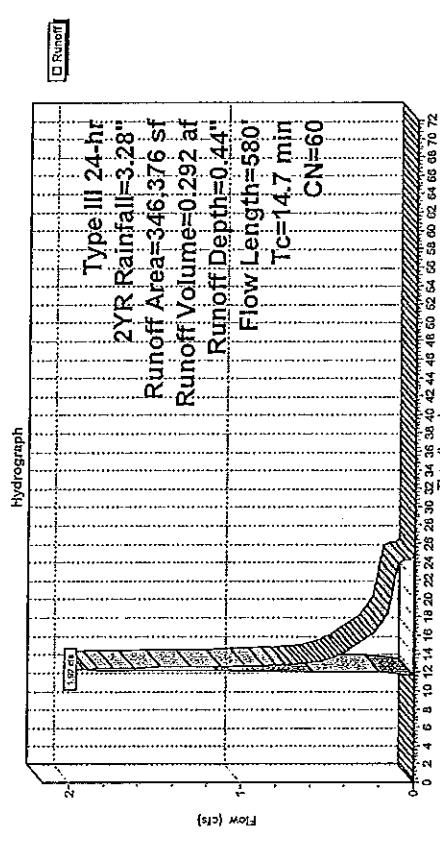
**Summary for Subcatchment 4P: DA#4P**

$$\text{Runoff} = 1.92 \text{ cfs} @ 12:31 \text{ hrs, Volume=} 0.292 \text{ af, Depth=} 0.44"$$

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 2YR Rainfall=3.28"

Area (sf)	CN	Description			
131,794	98	Paved parking & roofs			
182,950	61	>75% Grass cover, Good, HSG B			
68,163	55	Woods, Good, HSG B			
382,917	73	Weighted Average			
251,123		65.58% PerVIOUS Area			
131,794		34.42% Impervious Area			
Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.1	50	0.0250	0.16	Sheet Flow, TRAVEL PATH A TO B	
				Grass: Short n= 0.150 P2= 3.20"	
0.3	80	0.0750	4.41	Shallow Concentrated Flow, TRAVEL PATH B TO C	
				Unpaved Kv= 16.1 fps	
9.3	450	0.0260	0.81	Shallow Concentrated Flow, TRAVEL PATH C TO D	
				Woodland Kv= 5.0 fps	
14.7	580	Total			

**Subcatchment 4P: DA#4P**



post development 1-17  
 Prepared by {enter your company name here}  
 HydroCAD Software Solutions LLC  
 10.00-16 sm 01433 © 2015 HydroCAD Software Solutions LLC

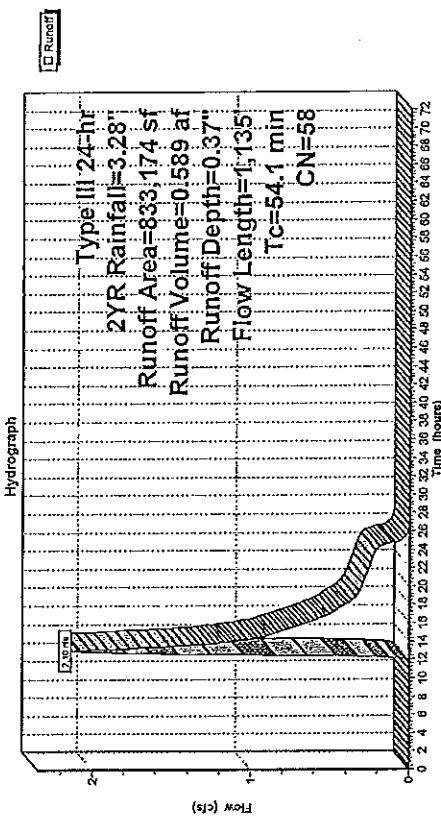
Type III 24-hr 2YR Rainfall=3.28"  
 Printed 2/1/2017  
 Prepared by {enter your company name here}  
 HydroCAD® 10.00-16 sm 01433 © 2015 HydroCAD Software Solutions LLC  
 Page 9

### Summary for Subcatchment 5P: DA#5P

Runoff = 2.10 cfs @ 12.97 hrs, Volume= 0.539 af, Depth= 0.37"  
 Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 2YR Rainfall=3.28"

Tc	Length (min)	Slope (feet)	Velocity (ft/sec)	Capacity (cfs)	Description
21.5	50	0.0200	0.04	Sheet Flow, TRAVEL PATH A TO B	
				Woods: Dense underbrush n= 0.800 P2= 3.20'	
31.2	935	0.0100	0.50	Shallow Concentrated Flow, TRAVEL PATH B TO C	
				Woodland Kv= 5.0 lps	
1.4	150	0.0300	1.73	Shallow Concentrated Flow, TRAVEL PATH C TO D	
				Nearly Bare & Untilled Kv= 10.0 lps	
54.1	1,135	Total			

### Subcatchment 5P: DA#5P



post development 1-17  
 Prepared by {enter your company name here}  
 HydroCAD® 10.00-16 sm 01433 © 2015 HydroCAD Software Solutions LLC

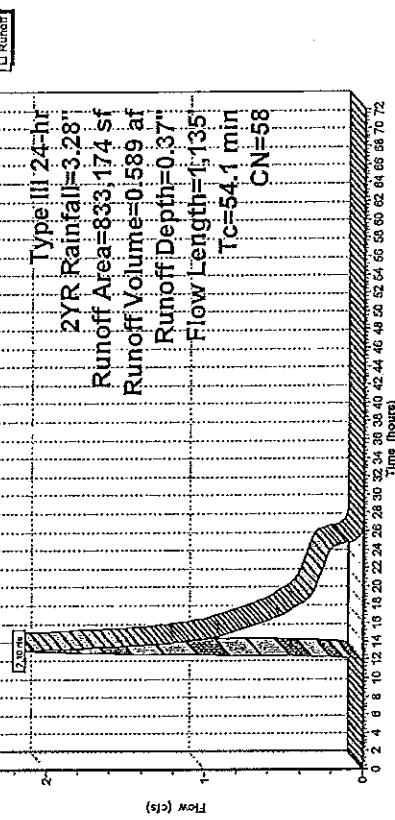
Type III 24-hr 2YR Rainfall=3.28"  
 Printed 2/1/2017  
 Prepared by {enter your company name here}  
 HydroCAD® 10.00-16 sm 01433 © 2015 HydroCAD Software Solutions LLC  
 Page 10

### Summary for Subcatchment 6S: 6P

Runoff = 2.33 cfs @ 12.66 hrs, Volume= 0.427 af, Depth= 0.60"  
 Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 2YR Rainfall=3.28"

Area (sf)	CN	Description	Area (sf)	CN	Description
49,012	98	Water Surface, HSG B	49,012	98	Water Surface, HSG B
206,262	61	>75% Grass cover, Good, HSG B	206,262	61	>75% Grass cover, Good, HSG B
118,543	55	Woods, Good, HSG B	118,543	55	Woods, Good, HSG B
373,817	64	Weighted Average	324,805	86.89%	Pervious Area
49,012			49,012		13.11% Impervious Area
Tc	Length (min)	Slope (feet)	Velocity (ft/sec)	Capacity (cfs)	Description
18.3	50	0.0300	0.05	Sheet Flow, TRAVEL PATH A TO B	
				Woods: Dense underbrush n= 0.800 P2= 3.20'	
1.6	135	0.0800	1.41	Shallow Concentrated Flow, TRAVEL PATH B TO C	
				Woodland Kv= 5.0 lps	
19.4	555	0.0330	0.48	Travel Year/Rect Channel Flow, TRAVEL C TO D	
				Bot,V=2.0' Z= 2.0' Top,W=6.0'	
0.4	283	0.0500	11.99	1.91 Pipe Channel, TRAVEL PATH D TO E	
				12.5" Round Area= 0.8 sf Perim= 3.1' r= 0.25'	
39.7	1,023	Total	n= 0.011	Concrete pipe, finished	

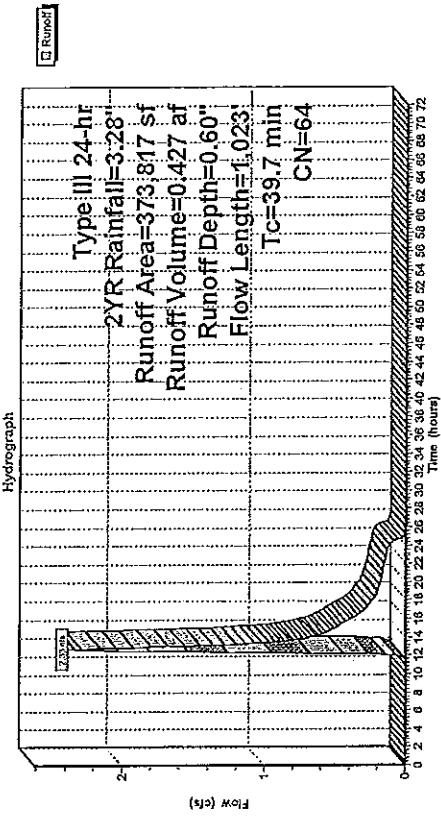
### Subcatchment 6S: 6P



**post development 1-17**  
Prepared by {enter your company name here}  
HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 2YR Rainfall=3.28"  
Printed 2/1/2017  
Page 11

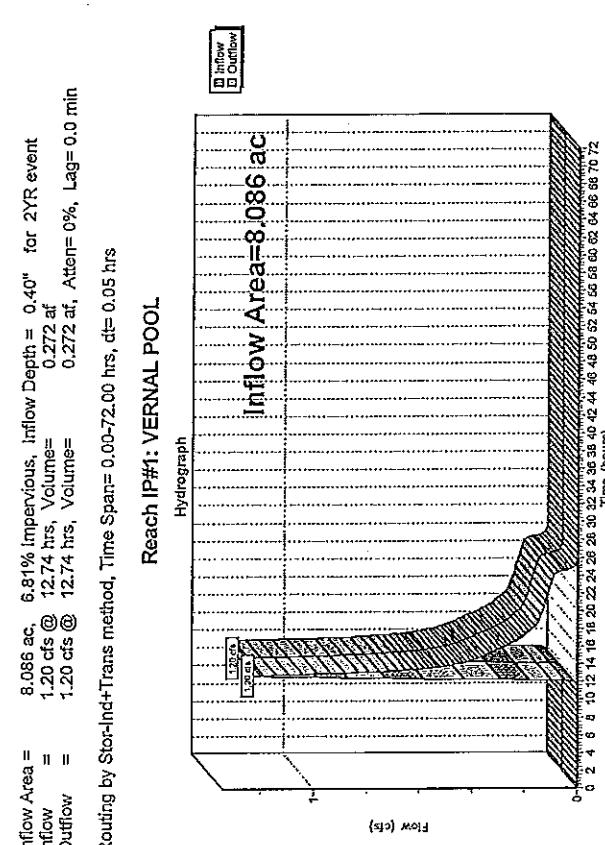
#### Subcatchment 6S: 6P



**post development 1-17**  
Prepared by {enter your company name here}  
HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 2YR Rainfall=3.28"  
Printed 2/1/2017  
Page 12

#### Summary for Reach IP#1: VERNAL POOL



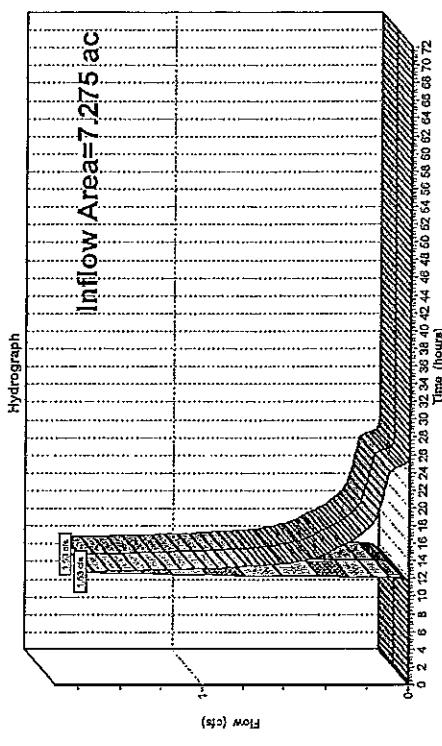
post development 1-17  
Prepared by {enter your Company name here}  
HydroCAD® 10.00-16 sn 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 2YR Rainfall=3.28"  
Printed 2/1/2017  
Page 13

#### Summary for Reach IP#2: PROP LINE

Inflow Area = 7.275 ac, 7.32% Impervious, Inflow Depth = 0.52" for 2YR event  
Inflow = 1.53 cfs @ 12.74 hrs, Volume= 0.313 af  
Outflow = 1.53 cfs @ 12.74 hrs, Volume= 0.313 af, Atten= 0%, Lag= 0.0 min  
Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

#### Reach IP#2: PROP LINE



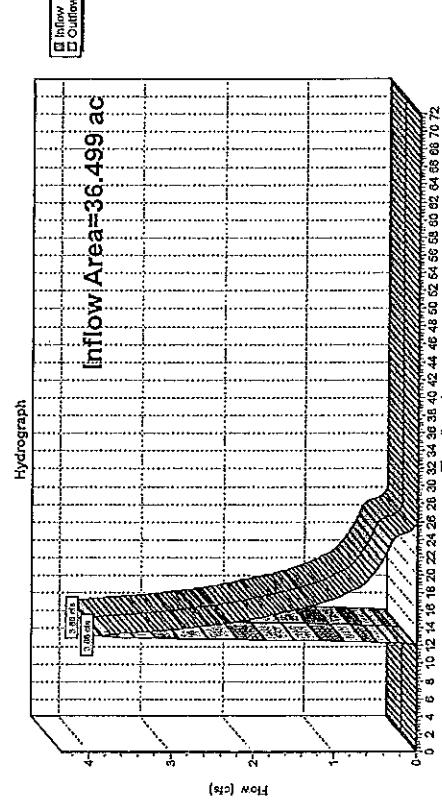
post development 1-17  
Prepared by {enter your Company name here}  
HydroCAD® 10.00-16 sn 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 2YR Rainfall=3.28"  
Printed 2/1/2017  
Page 14

#### Summary for Reach IP#3: WETLANDS

Inflow Area = 36.499 ac, 13.52% Impervious, Inflow Depth = 0.39" for 2YR event  
Inflow = 3.85 cfs @ 13.12 hrs, Volume= 1.194 af  
Outflow = 3.86 cfs @ 13.12 hrs, Volume= 1.194 af, Atten= 0%, Lag= 0.0 min  
Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

#### Reach IP#3: WETLANDS



**post development 1-17**  
 Prepared by {enter your company name here}  
 HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 2YR Rainfall=3.28"  
 Printed 2/1/2017  
 Page 15

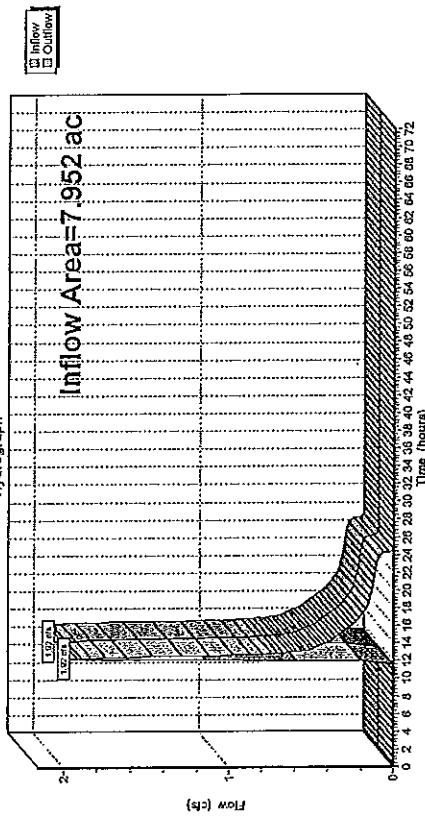
#### Summary for Reach IP#4: PROP. LINE

Inflow Area = 7.952 ac, 4.43% Impervious, Inflow Depth = 0.44" for 2YR event  
 Inflow = 1.92 cfs @ 12.31 hrs, Volume= 0.232 af, Atten= 0%, Lag= 0.0 min  
 Outflow = 1.92 cfs @ 12.31 hrs, Volume= 0.232 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

#### Reach IP#4: PROP. LINE

##### Hydrograph



**post development 1-17**  
 Prepared by {enter your company name here}  
 HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 2YR Rainfall=3.28"  
 Printed 2/1/2017  
 Page 15

#### Summary for Reach IP#4: PROP. LINE

Inflow Area = 8.791 ac, 34.42% Impervious, Inflow Depth = 1.03" for 2YR event  
 Inflow = 6.22 cfs @ 12.37 hrs, Volume= 0.758 af, Atten= 79%, Lag= 55.6 min  
 Outflow = 1.32 cfs @ 13.29 hrs, Volume= 0.758 af, Atten= 79%, Lag= 55.6 min  
 Discarded = 0.22 cfs @ 13.29 hrs, Volume= 0.413 af, Atten= 79%, Lag= 55.6 min  
 Primary = 1.10 cfs @ 13.29 hrs, Volume= 0.345 af, Atten= 79%, Lag= 55.6 min

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs  
 Peak Elev= 375.66' @ 13.29 hrs Surf.Area= 9,245 sf Storage= 13,641 cf  
 Plug-Flow detention time= 328.9 min calculated for 0.758 af (100% of inflow)  
 Center-of-Mass det. time= 328.5 min ( 1,209.1 - 880.6 )

Volume	Invert	Avail.Storage	Storage Description
#1	374.00'	82,639 cf	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
374.00	7,184	0	0
376.00	9,666	16,850	16,850
378.00	12,357	22,023	38,873
380.00	15,306	27,663	66,536
381.00	16,900	16,103	82,639

Device Routing Invert Outlet Devices  
 #1 Discarded 374.00' 1.020 Inhr Exfiltration over Surface area  
 #2 Primary 375.00' 6.0" Vert. Orifice/Grate C= 0.600  
 #3 Primary 375.25' 3.0" Vert. Orifice/Grate C= 0.600  
 #4 Primary 378.25' 12.0" Vert. Orifice/Grate C= 0.600

Discarded OutFlow Max=0.22 cfs @ 13.29 hrs HW=375.66' (Free Discharge)

↓=1=Exfiltration (Exfiltration Controls 0.22 cfs)

Primary OutFlow Max=1.10 cfs @ 13.29 hrs HW=375.66' (Free Discharge)

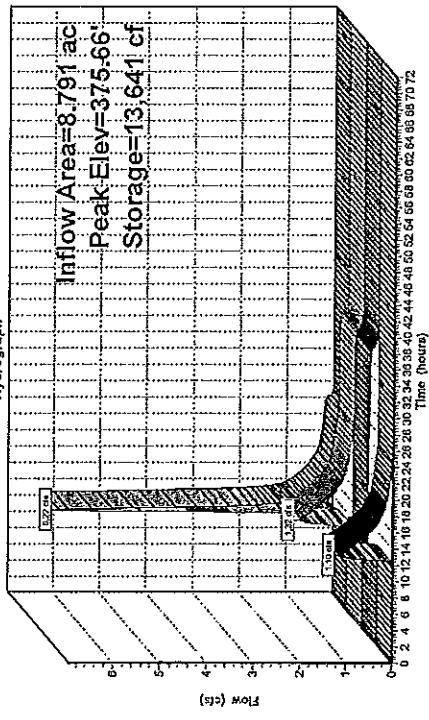
↓=2=Orifice/Grate (Orifice Controls 0.61 cfs @ 3.00 ips)

↓=3=Orifice/Grate (Orifice Controls 0.49 cfs @ 2.18 ips)

↓=4=Orifice/Grate (Controls 0.00 cfs)

### Pond 5PND: BASIN#1

Hydrograph



### Summary for Pond 7P: BASIN#2

Inflow Area = 8.582 ac. 13.11% Impervious. Inflow Depth = 0.60" for 2YR event  
 Inflow = 2.33 cfs @ 12.66 hrs, Volume= 0.427 af  
 Outflow = 0.99 cfs @ 13.42 hrs, Volume= 0.427 af, Atten= 57%, Lag= 45.3 min  
 Discarded = 0.11 cfs @ 13.42 hrs, Volume= 0.168 af  
 Primary = 0.89 cfs @ 13.42 hrs, Volume= 0.259 af

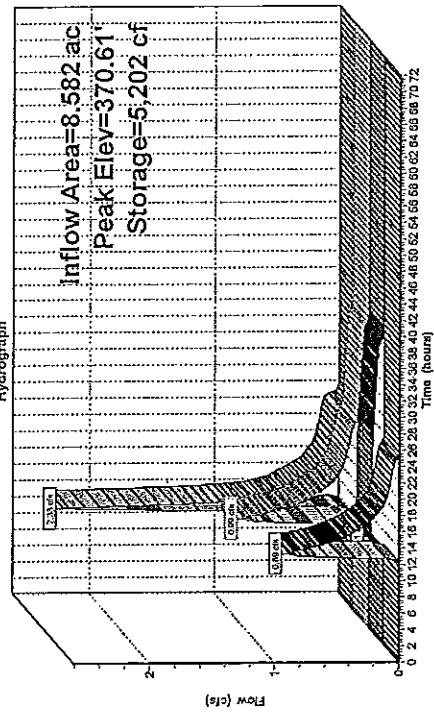
Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs  
 Peak Elev= 370.61' @ 13.42 hrs Surf.Area= 4,556 sf Storage= 5,202 cf

Plug-Flow detention time= 199.9 min calculated for 0.427 af (100% of inflow).  
 Center-of-Mass det. time= 199.6 min (1,128.1 - 928.5)

Volume	Invert	Avail.Storage	Storage Description		
			Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
#1	369.00'	38,325 cf	Custom Stage Data (Prismatic) Listed below (Recalc)		
369.00	1,600	0			
370.00	3,750	2,675	2,675		
372.00	6,400	10,150	12,825		
374.00	9,300	15,700	28,525		
375.00	10,300	9,800	38,325		

Device	Routing	Invert	Outlet Devices
#1	Discarded	369.00'	1,020 in/hr Exfiltration over Surface area
#2	Primary	370.00'	8.0" Vert. Orifice/Grate C= 0.600
#3	Primary	370.75'	10.0" Vert. Orifice/Grate C= 0.600
#4	Primary	372.85'	12.0" Vert. Orifice/Grate C= 0.600
			Discarded Outflow Max=0.11 cfs @ 13.42 hrs HW=370.61' (Free Discharge)
			1=Exfiltration (Exfiltration Controls 0.11 cfs)
			2=Orifice/Grate (Orifice Controls 0.39 cfs @ 2.66 cfs)
			3=Orifice/Grate (Controls 0.00 cfs)
			4=Orifice/Grate (Controls 0.00 cfs)

Hydrograph



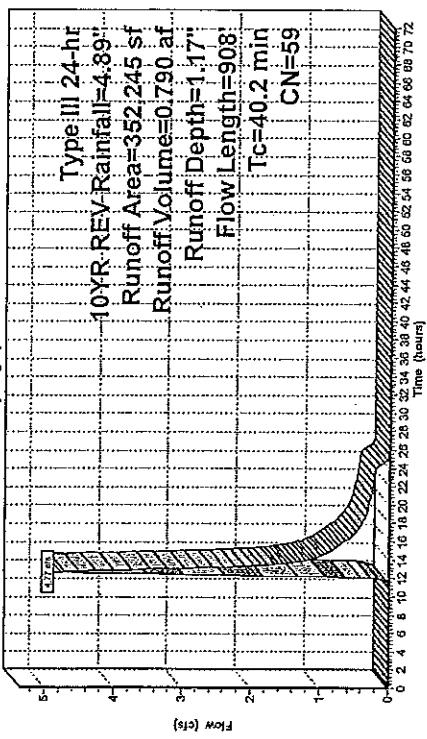
#### Summary for Subcatchment 1P: DA#1P

Runoff = 4.77 cfs @ 12.64 hrs, Volume= 0.790 af, Depth= 1.17"  
 Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 10YR REV Rainfall=4.89"

Area (sf)	CN	Description			
24,004	98	Paved parking & roofs			
80,175	61	>75% Grass cover, Good, HSG B			
248,066	55	Woods, Good, HSG B			
352,245	59	Weighted Average			
328,241		93.19% Pervious Area			
24,004		6.81% Impervious Area			
Tc	Length	Slope	Velocity	Capacity	Description
(min)	(feet)	(ft/sec)	(ft/sec)	(cfs)	
28.3	50	0.0100	0.03		Sheet Flow, TRAVEL PATH A TO B
7.2	409	0.0360	0.95		Woods; Dense underbrush n= 0.800 P2= 3.20"
1.3	140	0.0150	1.84		Shallow Concentrated Flow, TRAVEL PATH B TO C
0.3	100	0.0150	6.02	4.73	Woodland Kv= 5.0 fips
0.8	89	0.0150	1.84		Shallow Concentrated Flow, TRAVEL PATH C TO D
2.3	120	0.0300	0.87		Grassed Waterway Kv= 15.0 fips
40.2	908	Total			Pipe Channel, TRAVEL PATH D TO E
					12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'
					n= 0.12 Concrete pipe, finished
					Shallow Concentrated Flow, TRAVEL PATH E TO F
					Grassed Waterway Kv= 15.0 fips
					Shallow Concentrated Flow, TRAVEL PATH F TO G
					Woodland Kv= 5.0 fips

### Subcatchment 1P: DA#1P

Hydrograph



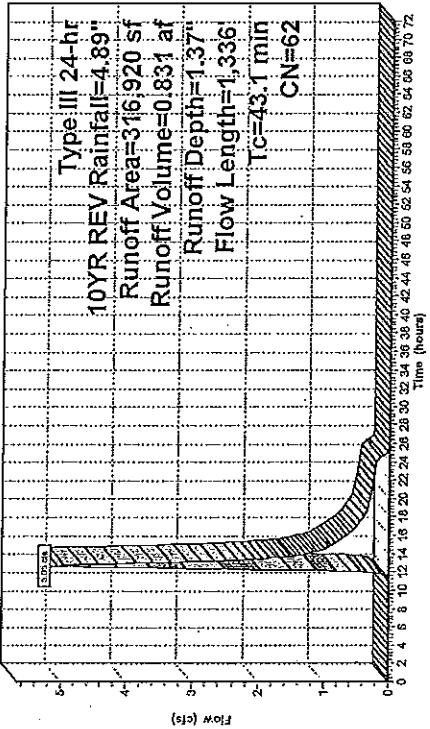
### Summary for Subcatchment 2P: DA#2P

Runoff = 5.05 cfs @ 12.66 hrs, Volume= 0.831 af, Depth= 1.37"  
 Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 10YR REV Rainfall=4.89"

Area (sf)	CN	Description			
23,199	98	Paved parking & roofs			
127,802	61	>75% Grass cover; Good, HSG B			
165,919	58	Woods/grass comb.; Good, HSG B			
316,920	62	Weighted Average			
293,721	92.68%	Pervious Area			
23,199		7.32% Impervious Area			
Tc	Length	Slope	Velocity	Capacity	Description
(min)	(feet)	(ft/sec)	(ft/sec)	(cfs)	
28.3	50	0.0100	0.03	Sheet Flow, TRAVEL PATH A TO B	
					Woods; Dense underbrush $r=0.800$ $P2=3.20"$
9.2	275	0.0100	0.50	Shallow Concentrated Flow, TRAVEL PATH B TO C	
					Woodland $Ku=5.0$ fps
4.2	901	0.0500	3.60	Shallow Concentrated Flow, TRAVEL PATH C TO D	
					Unpaved $Ku=16.1$ fps
1.4	110	0.0720	1.34	Shallow Concentrated Flow, TRAVEL PATH D TO E	
					Woodland $Ku=5.0$ fps
43.1	1,336	Total			

### Subcatchment 2P: DA#2P

Hydrograph



[Runoff]

**post development 1-17**  
 Prepared by [enter your company name here]  
 HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 10YR REV Rainfall=4.89"  
 Printed 2/1/2017  
 Page 23

Type III 24-hr 10YR REV Rainfall=4.89"  
 Prepared by [enter your company name here]  
 HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 10YR REV Rainfall=4.89"  
 Printed 2/1/2017  
 Page 24

Type III 24-hr 10YR REV Rainfall=4.89"  
 Prepared by [enter your company name here]  
 HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC

**Summary for Subcatchment 3P: DA#3P**

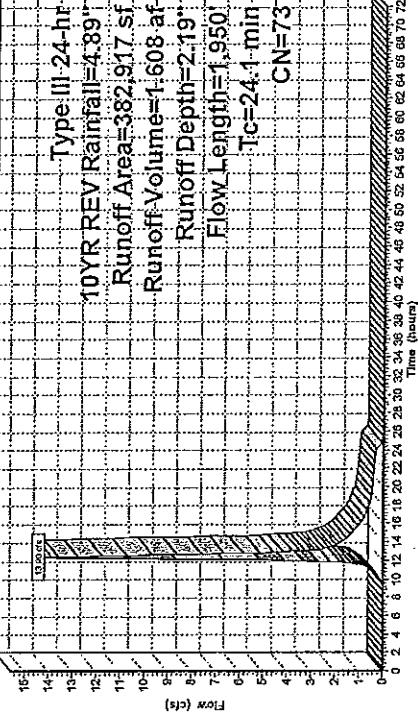
$$\text{Runoff} = 13.90 \text{ cfs} @ 12.35 \text{ hrs. Volume=} 1.608 \text{ af, Depth=} 2.19"$$

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 10YR REV Rainfall=4.89"

Tc	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.3	50	0.0400	0.05	Sheet Flow, TRAVEL PATH A TO B	
				Woods: Dense underbrush n= 0.800 P2= 3.20"	
0.8	200	0.0600	3.94	Shallow Concentrated Flow, TRAVEL PATH B TO C	
				Unpaved Kv= 16.1 fps	
7.0	1,700	0.0400	4.06	Shallow Concentrated Flow, TRAVEL PATH C TO D	
				Paved Kv= 20.3 tps	
24.1	1,950	Total			

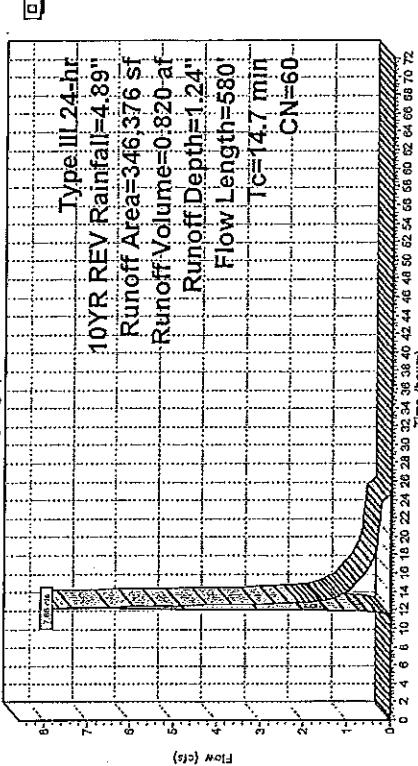
**Subcatchment 3P: DA#3P**

Hydrograph



**Summary for Subcatchment 4P: DA#4P**

Hydrograph



**Subcatchment 4P: DA#4P**

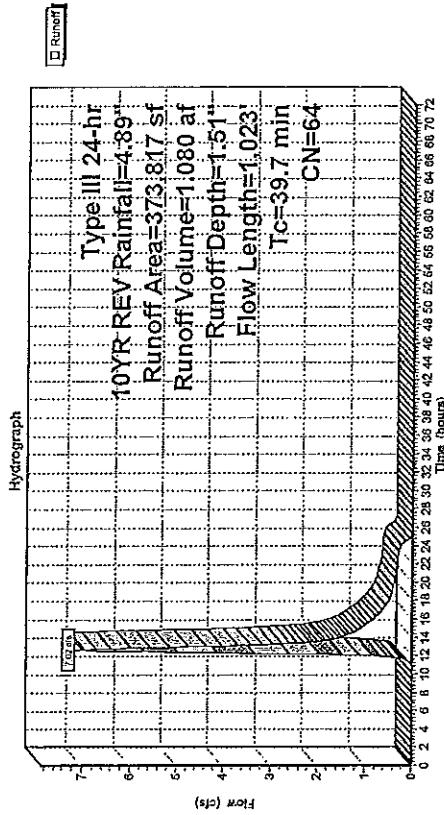
Hydrograph



post development 1-17  
Prepared by [enter your company name here],  
HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 10YR REV Rainfall=4.89"  
Printed 2/1/2017  
Page 27

#### Subcatchment 6S: 6P



post development 1-17  
Prepared by [enter your company name here],  
HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC

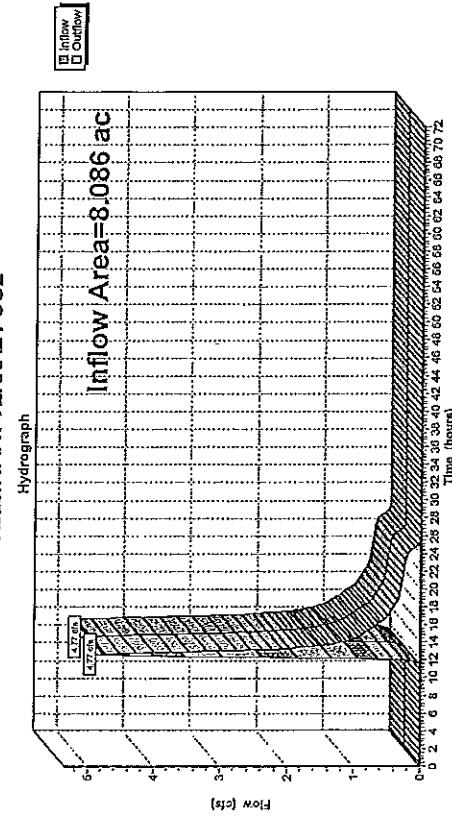
Type III 24-hr 10YR REV Rainfall=4.89"  
Printed 2/1/2017  
Page 28

#### Summary for Reach IP#1: VERNAL POOL

Inflow Area = 8.086 ac, 6.81% Impervious, Inflow Depth = 1.17" for 10YR REV event  
Inflow = 4.77 cfs @ 12.64 hrs, Volume = 0.790 af  
Outflow = 4.77 cfs @ 12.64 hrs, Volume = 0.790 af, Atten= 0%, Lag= 0.0 min

Routing by Sto:Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

#### Reach IP#1: VERNAL POOL



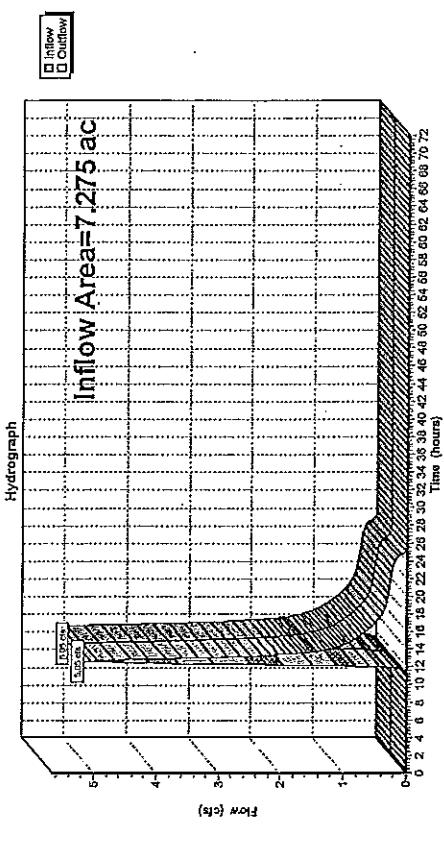
post development 1-17  
Prepared by {enter your company name here}  
HydroCAD® 10.00-16 sn 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 10YR REV Rainfall=4.89"  
Printed 2/5/2017  
Page 29

### Summary for Reach IP#2: PROP LINE

Inflow Area = 7.275 ac, 7.32% Impervious, Inflow Depth = 1.37" for 10YR REV event  
Inflow = 5.05 cfs @ 12.66 hrs, Volume= 0.831 af  
Outflow = 5.05 cfs @ 12.66 hrs, Volume= 0.831 af, Atten= 0%, Lag= 0.0 min  
Routing by Sto-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

### Reach IP#2: PROP LINE



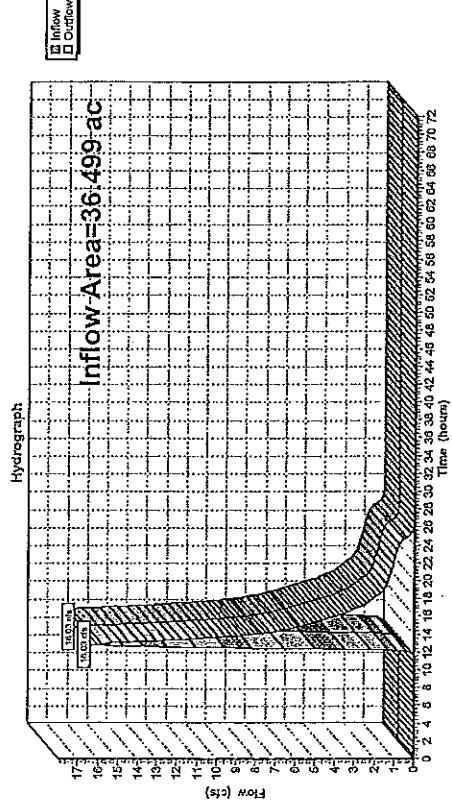
post development 1-17  
Prepared by {enter your company name here}  
HydroCAD® 10.00-16 sn 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 10YR REV Rainfall=4.89"  
Printed 2/1/2017  
Page 30

### Summary for Reach IP#3: WETLANDS

Inflow Area = 36.499 ac, 13.52% Impervious, Inflow Depth = 1.25" for 10YR REV event  
Inflow = 16.03 cfs @ 12.88 hrs, Volume= 3.802 af  
Outflow = 16.03 cfs @ 12.88 hrs, Volume= 3.802 af, Atten= 0%, Lag= 0.0 min  
Routing by Sto-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

### Reach IP#3: WETLANDS



#### Summary for Reach IP#4: PROP. LINE

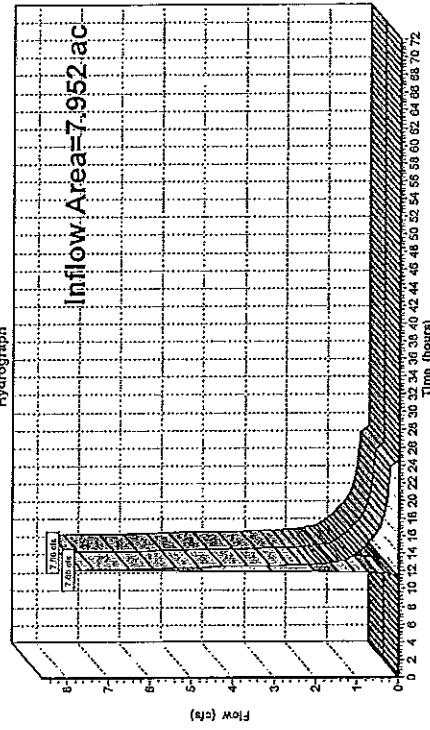
Inflow Area = 7.952 ac, 4.43% Impervious, Inflow Depth = 1.24" for 10YR REV event  
 Inflow = 7.66 cfs @ 12.23 hrs, Volume= 0.820 af  
 Outflow = 7.66 cfs @ 12.23 hrs, Volume= 0.820 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach IP#4: PROP. LINE



**Hydrograph**



#### Summary for Pond 5PND: BASIN#1

Inflow Area = 8.791 ac, 34.42% impervious, Inflow Depth = 2.19" for 10YR REV event  
 Inflow = 13.90 cfs @ 12.35 hrs, Volume= 1.608 af  
 Outflow = 3.60 cfs @ 13.03 hrs, Volume= 1.608 af, Atten= 74%, Lag= 41.0 min  
 Discarded = 0.26 cfs @ 13.03 hrs, Volume= 0.465 af  
 Primary = 3.33 cfs @ 13.03 hrs, Volume= 1.142 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs  
 Peak Elev= 377.08' @ 13.03 hrs Surf.Area= 11.118 sf Storage= 28,066 cf

Plug-Flow detention time= 209.5 min calculated for 1.606 af (100% of inflow)  
 Center-of-Mass det. time= 210.0 min (1,067.9 - 857.9)

Volume	Invert	Avail.Storage	Storage Description	Custom Stage Data (Prismatic) Listed below (Recalc)
#1	374.00'	82,639 cf		
Elevation	Surf.Area	Incr.Store	Cum.Store	
(feet)	(sq-ft)	(cubic-feet)	(cubic-feet)	
374.00	7,184	0	0	
376.00	9,666	16,850	16,850	
378.00	12,357	22,023	38,873	
380.00	15,306	27,563	66,536	
381.00	16,900	16,103	82,639	
Device	Routing	Invert	Outlet Devices	
#1	Discarded	374.00'	1.020 in/hr Exfiltration over Surface area	
#2	Primary	375.00'	6.01 Vert. Orifice/Grate C= 0.800	
#3	Primary	375.25'	8.0" Vert. Orifice/Grate C= 0.800	
#4	Primary	378.25'	12.0" Vert. Orifice/Grate C= 0.600	
Discarded OutFlow Max=0.26 cfs @ 13.03 hrs HW=377.08' (Free Discharge)				

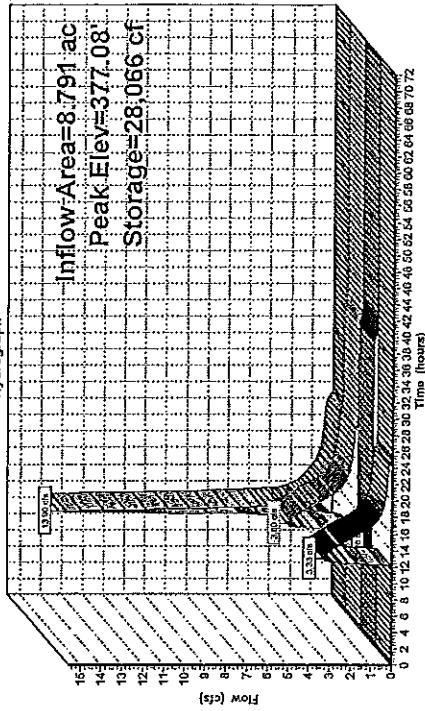
↓=Exfiltration (Exfiltration Controls 0.26 cfs)  
 Primary OutFlow Max=3.33 cfs @ 13.03 hrs HW=377.08' (Free Discharge)  
 ↑=2-Orifice/Grate (Orifice Controls 1.28 cfs @ 6.51 fps)  
 ↓=3-Orifice/Grate (Orifice Controls 2.06 cfs @ 5.89 fps)  
 └=4-Orifice/Grate (Controls 0.00 cfs)

post development 1-17  
Prepared by [enter your company name here]  
HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 10YR REV Rainfall=4.89"  
Printed 2/1/2017  
Page 33  
Prepared by [enter your company name here]  
HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC

### Pond 5PND: BASIN#1

Hydrograph



post development 1-17  
Prepared by [enter your company name here]  
HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 10YR REV Rainfall=4.89"  
Printed 2/1/2017  
Page 33  
Prepared by [enter your company name here]  
HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC

### Summary for Pond 7P: BASIN#2

Inflow Area = 8.582 ac, 13.11% Impervious, Inflow Depth = 1.57" for 10YR REV event  
Inflow = 7.02 cfs @ 12.60 hrs, Volume= 1,080 af  
Outflow = 4.19 cfs @ 13.03 hrs, Volume= 1,080 af, Attenu= 40%, Lag= 25.5 min  
Discarded = 0.14 cfs @ 13.03 hrs, Volume= 0.187 af  
Primary = 4.04 cfs @ 13.03 hrs, Volume= 0.893 af

Routing by Short-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs  
Peak Elev= 377.77' @ 13.03 hrs Surf.Area= 6,089 sf Storage= 11,358 cf

Plug-Flow detention time= 105.0 min calculated for 1.079 af (100% of inflow)  
Center-of-Mass det. time= 105.5 min (1.001.8 - 896.3)

Volume	Invert	Avail.Storage	Custom Stage Data (Prismatic) Listed below (Recalc)
#1	369.00'	38,325 cf	
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
369.00	1,600	0	0
370.00	3,750	2,675	2,675
372.00	6,400	10,150	12,825
374.00	9,300	15,700	28,525
375.00	10,300	9,800	38,325

Device Routing Invert Outlet Devices

#1 Discarded 369.00' 1.020 in/hr Exfiltration over Surface area  
#2 Primary 370.00' 8.0" Vert. Orifice/Grate C= 0.600  
#3 Primary 370.75' 10.0" Vert. Orifice/Grate C= 0.600  
#4 Primary 372.85' 12.0" Vert. Orifice/Grate C= 0.600

Discarded Outflow Max=0.14 cfs @ 13.03 hrs HW=371.76' (Free Discharge)  
1=Exfiltration (Exfiltration Controls 0.14 cfs)

Primary Outflow Max=4.04 cfs @ 13.03 hrs HW=371.76' (Free Discharge)  
2=Orifice/Grate (Orifice Controls 2.01 cfs @ 5.76 tps)  
3=Orifice/Grate (Orifice Controls 2.03 cfs @ 3.72 tps)  
4=Orifice/Grate (Controls 0.00 cfs)

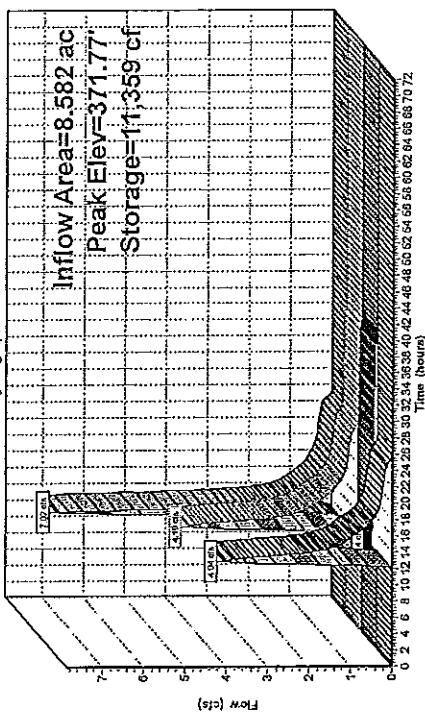
**post development 1-17**  
Prepared by {enter your company name here}  
HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC

Type III/24-hr 10YR REV Rainfall=4.89"  
Printed 2/1/2017  
Page 35

Type III/24-hr 25YR REV Rainfall=6.22"  
Prepared by {enter your company name here}  
HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC  
Printed 2/1/2017  
Page 36

### Pond 7P: BASIN#2

#### Hydrograph



**post developmentmen 1-17**  
Prepared by {enter your company name here}  
HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC

Type III/24-hr 25YR REV Rainfall=6.22"  
Prepared by {enter your company name here}  
HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC  
Printed 2/1/2017  
Page 36

### Summary for Subcatchment IP: DA#1P

Runoff = 3.67 cfs @ 12.60 hrs, Volume= 1.335 af, Depth= 1.98"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs  
Type III/24-hr 25YR REV Rainfall=6.22"

Area (sf)	CN	Description
24,004	98	Paved parking & roofs
80,175	61	>75% Grass cover, Good, HSG B
248,056	55	Woods, Good, HSG B
352,245	59	Weighted Average
328,241		93.19% Pervious Area
24,004		6.81% Impervious Area

Tc Length Slope Velocity Capacity Description

(min) (feet) (ft/ft) (ft/sec) (cfs)

28.3 50 0.0100 0.03 Sheet Flow, TRAVEL PATH A TO B

7.2 409 0.0360 0.95 Woods: Dense underbrush n= 0.800 P2= 3.20"

Shallow Concentrated Flow, TRAVEL PATH B TO C

Woodland Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH C TO D

Grassed Waterway Kv= 15.0 fps

12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'

n= 0.012 Concrete pipe, finished

Shallow Concentrated Flow, TRAVEL PATH D TO E

Pipe Channel, TRAVEL PATH D TO E

Grassed Waterway Kv= 15.0 fps

Shallow Concentrated Flow, TRAVEL PATH E TO F

Grassed Waterway Kv= 15.0 fps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

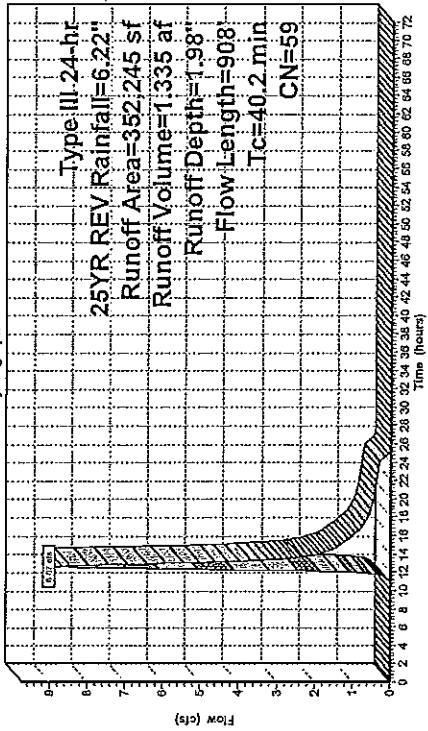
Shallow Concentrated Flow, TRAVEL PATH F TO G

Woods Ky= 5.0 lps

Shallow Concentrated Flow, TRAVEL PATH F TO G

### Subcatchment 1P: DA#1P

Hydrograph



Runoff

Type III 24-hr  
 25YR REV Rainfall=6.22"  
 Runoff Area=352.245 sf  
 Runoff Volume=1.335 af  
 Runoff Depth=1.98'  
 Flow Length=908'  
 Tc=40.2 min  
 CN=59

43.1 1,336 Total

### Summary for Subcatchment 2P: DA#2P

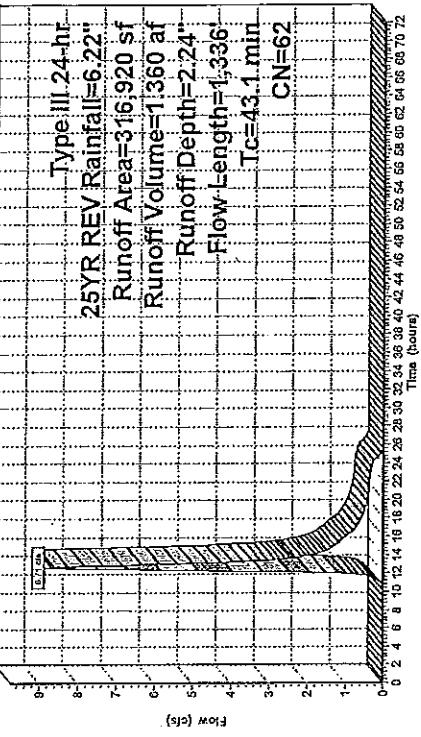
Runoff = 8.71 cfs @ 12.63 hrs, Volume= 1.360 af, Depth= 2.24"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 25YR REV Rainfall=6.22"

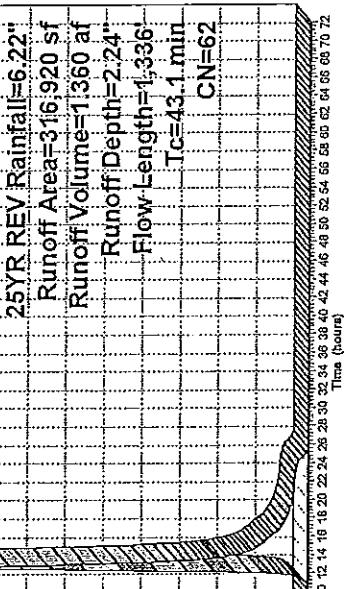
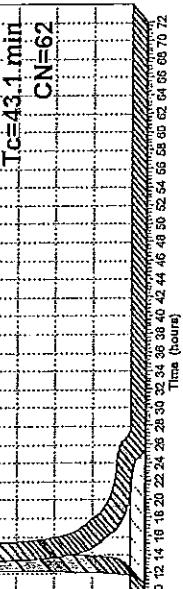
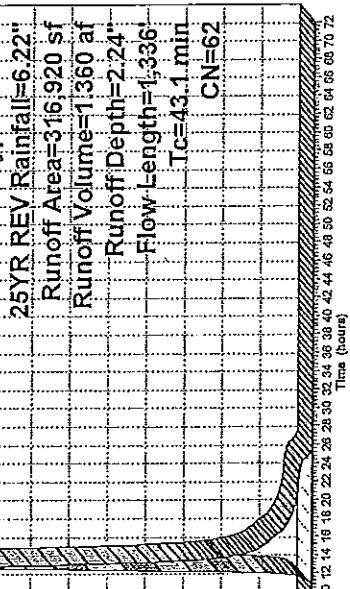
Area (sf)	CN	Description			
23,99	98	Paved parking & roofs			
127,802	61	>75% Grass cover, Good, HSG B			
165,919	58	Woods/grass comb., Good, HSG B			
316,920	62	Weighted Average			
283,721	92	88% Pervious Area			
23,199	732	7.32% Impervious Area			
Tc	Length	Slope	Velocity	Capacity	Description
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	
28.3	50	0.0100	0.03		Sheet Flow, TRAVEL PATH A TO B
					Woods: Dense underbrush, n=0.800, P2=3.20'
					Shallow Concentrated Flow, TRAVEL PATH B TO C
					Woodland Kv= 5.0 fps
					Shallow Concentrated Flow, TRAVEL PATH C TO D
					Unpaved Kv= 16.1 fps
					Shallow Concentrated Flow, TRAVEL PATH D TO E
					Woodland Kv= 5.0 fps

Subcatchment 2P: DA#2P

Hydrograph



E Runoff



**post development 1-17** Type III 24-hr 25YR REV Rainfall=6.22"  
 Prepared by [enter your company name here] Printed 2/1/2017  
 HydroCAD® 10.00-16 s/n 01453 © 2015 HydroCAD Software Solutions LLC Page 39

Type III 24-hr 25YR REV Rainfall=6.22"  
 Printed 2/1/2017  
 HydroCAD® 10.00-16 s/n 01453 © 2015 HydroCAD Software Solutions LLC Page 39

#### Summary for Subcatchment 3P: DA#3P

Runoff = 20.93 cfs @ 12.34 hrs, Volume=

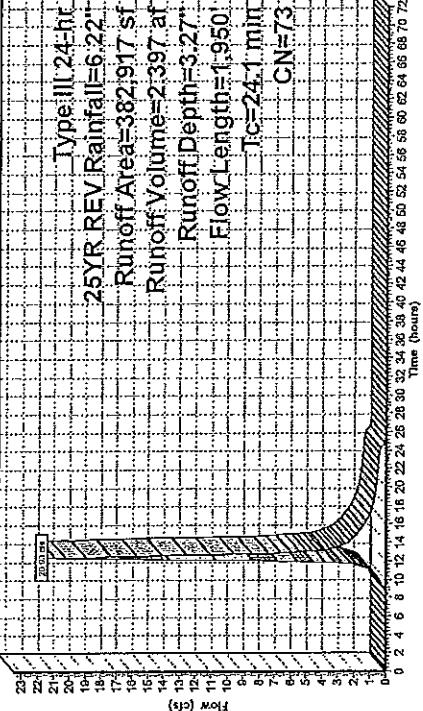
2.397 af, Depth= 3.27"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 25YR REV Rainfall=6.22"

Tc	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.3	50	0.0400	0.05	Sheet Flow, TRAVEL PATH A TO B	
					Woods; Dense underbrush n= 0.300 P2= 3.20"
0.8	200	0.0600	3.94		Shallow Concentrated Flow, TRAVEL PATH B TO C
					Unpaved Kv= 16.1 fps
7.0	1,700	0.0400	4.06		Shallow Concentrated Flow, TRAVEL PATH C TO D
					Paved Kv= 20.3 fips
24.1	1,950	Total			

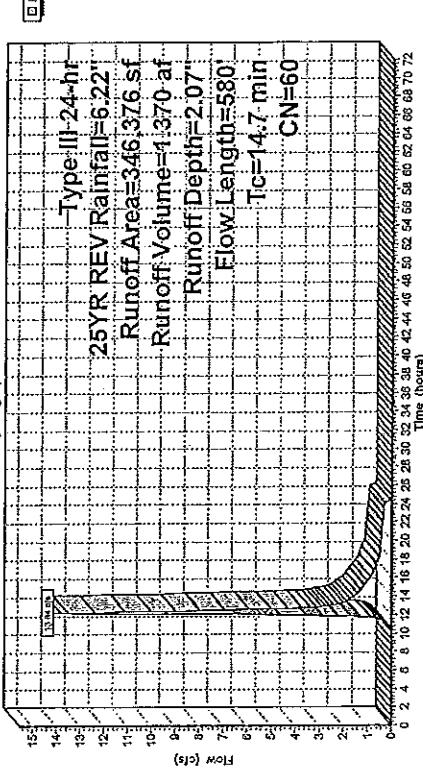
#### Subcatchment 3P: DA#3P

Hydrograph



#### Subcatchment 4P: DA#4P

Hydrograph



post development 1-17 Type III 24-hr 25YR REV Rainfall=6.22"  
 Prepared by [enter your company name here] Printed 2/1/2017  
 HydroCAD® 10.00-16 s/n 01453 © 2015 HydroCAD Software Solutions LLC Page 40

post development 1-17 Type III 24-hr 25YR REV Rainfall=6.22"  
 Prepared by [enter your company name here] Printed 2/1/2017  
 HydroCAD® 10.00-16 s/n 01453 © 2015 HydroCAD Software Solutions LLC Page 40

**post development 1-17**  
 Prepared by {enter your company name here}  
 HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 25YR REV Rainfall=6.22"  
 Printed 2/1/2017  
 Page 41

### Summary for Subcatchment 5P: DA#5P

$$\text{Runoff} = 16.48 \text{ cfs} @ 12.80 \text{ hrs, Volume=} 3.021 \text{ af, Depth=} 1.90"$$

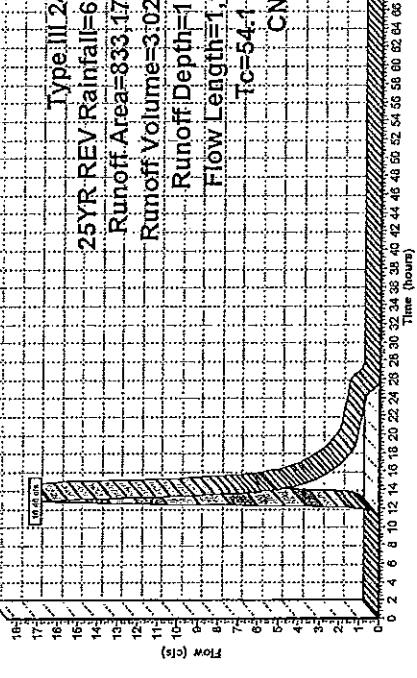
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 25YR REV Rainfall=6.22"

Area (sf)	CN	Description
34,219	98	Paved parking, HSG A
153,139	61	>75% Grass cover, Good, HSG B
645,816	55	Woods, Good, HSG B
833,174	58	Weighted Average
798,955	95.89%	Pervious Area
34,219	4.11%	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
21.5	50	0.0200	0.04	Sheet Flow, TRAVEL PATH A TO B	
				Woods; Dense Underbrush n= 0.800 P2= 3.20"	
31.2	935	0.0100	0.50	Shallow Concentrated Flow, TRAVEL PATH B TO C	
				Woodland Kv= 5.0 fps	
1.4	150	0.0300	1.73	Shallow Concentrated Flow, TRAVEL PATH C TO D	
				Nearly Bare & Untilled Kv= 10.0 fps	
<b>54.1</b>	<b>1,135</b>				
<b>Total</b>					

### Subcatchment 5P: DA#5P

#### Hydrograph



**post development 1-17**  
 Prepared by {enter your company name here}  
 HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 25YR REV Rainfall=6.22"  
 Printed 2/1/2017  
 Page 42

### Summary for Subcatchment 6S: 6P

$$\text{Runoff} = 11.71 \text{ cfs} @ 12.58 \text{ hrs, Volume=} 1.732 \text{ af, Depth=} 2.42"$$

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 25YR REV Rainfall=6.22"

Area (sf)	CN	Description
49,012	98	Water Surface, HSG B
206,232	61	>75% Grass cover, Good, HSG B
118,533	55	Woods, Good, HSG B
373,817	64	Weighted Average
324,805	86.89%	Previous Area
49,012	13.11%	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.3	50	0.0300	0.05	Sheet Flow, TRAVEL PATH A TO B	

Woods; Dense underbrush n= 0.800 P2= 3.20"  
 Shallow Concentrated Flow, TRAVEL PATH B TO C  
 Woodland Kv= 5.0 fps  
 Trap/Veet/Rect Channel Flow, TRAVEL C TO D  
 Bot,W=2.0' D=1.0' Z=2.0' Top,V=6.00'  
 n= 0.410 Sheet flow over Bermuda Grass  
 Pipe Channel, TRAVEL PATH D TO E  
 12.0" Round Area= 0.8 sf Perim= 3.1' I= 0.25'  
 n= 0.011 Concrete pipe, finished

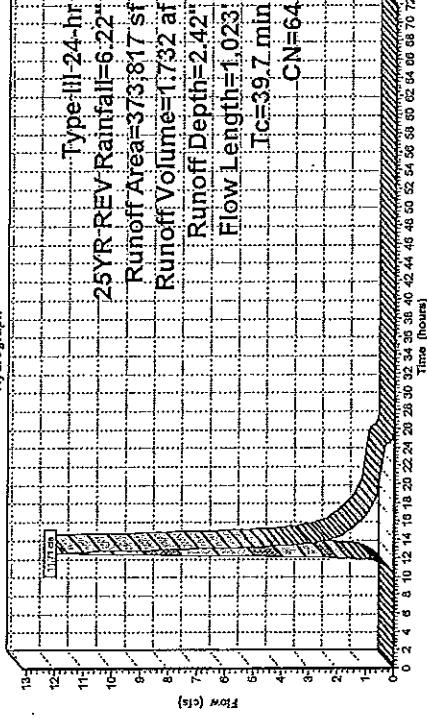
39.7 1,023 Total

**post development 1-17**  
Prepared by {enter your company name here}  
HydroCAD® 10.00-16 sn 01433 © 2015 HydroCAD Software Solutions LLC

**Type III 24-hr 25YR REV Rainfall=6.22"**  
Printed 2/12/2017  
Page 43

#### Subcatchment 6S: 6P

Hydrograph



**post development 1-17**  
Prepared by {enter your company name here}  
HydroCAD® 10.00-16 sn 01433 © 2015 HydroCAD Software Solutions LLC

**Type III 24-hr 25YR REV Rainfall=6.22"**  
Printed 2/1/2017  
Page 44

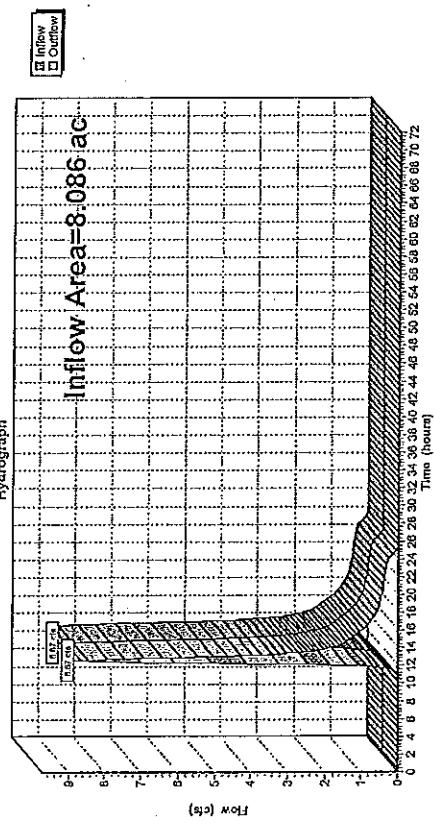
#### Summary for Reach IP#: VERNAL POOL

Inflow Area = 8.086 ac, 6.81% Impervious, Inflow Depth = 1.98" for 25YR REV event  
Inflow = 8.57 cfs @ 12.60 hrs, Volume= 1.335 af  
Outflow = 8.57 cfs @ 12.60 hrs, Volume= 1.335 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

#### Reach IP#1: VERNAL POOL

Hydrograph



post development 1-17  
Prepared by {enter your company name here}  
HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC

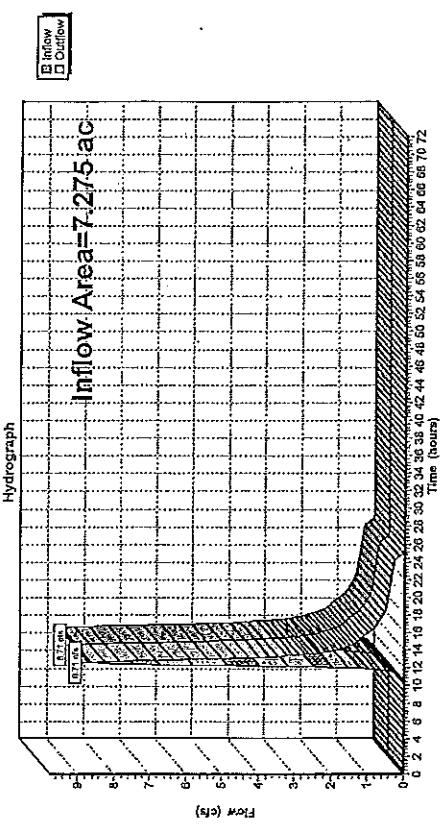
Type III 24-hr 25YR REV Rainfall=6.22"  
Printed 2/1/2017  
Page 45

#### Summary for Reach IP#2: PROP LINE

Inflow Area = 7.275 ac, 7.32% Impervious, Inflow Depth = 2.24" for 25YR REV event  
Inflow = 8.71 cfs @ 12.63 hrs, Volume= 1.360 af  
Outflow = 8.71 cfs @ 12.63 hrs, Volume= 1.360 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

#### Reach IP#2: PROP LINE



post development 1-17  
Prepared by {enter your company name here}  
HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC

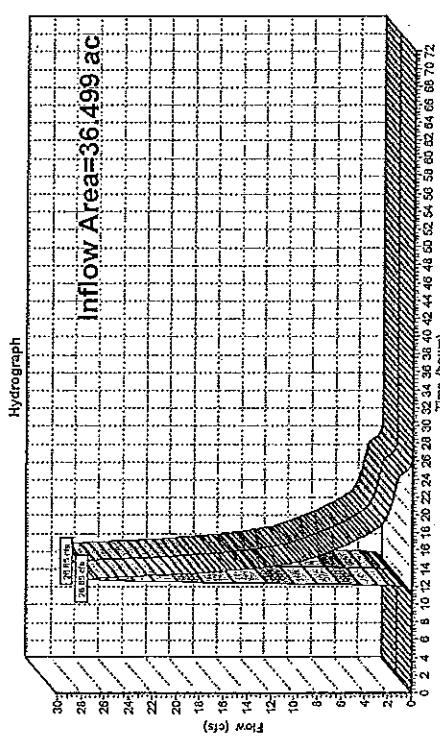
Type III 24-hr 25YR REV Rainfall=6.22"  
Printed 2/1/2017  
Page 46

#### Summary for Reach IP#3: WETLANDS

Inflow Area = 36.499 ac, 13.52% Impervious, Inflow Depth = 2.12" for 25YR REV event  
Inflow = 26.85 cfs @ 12.84 hrs, Volume= 6.443 af  
Outflow = 26.85 cfs @ 12.84 hrs, Volume= 6.443 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

#### Reach IP#3: WETLANDS



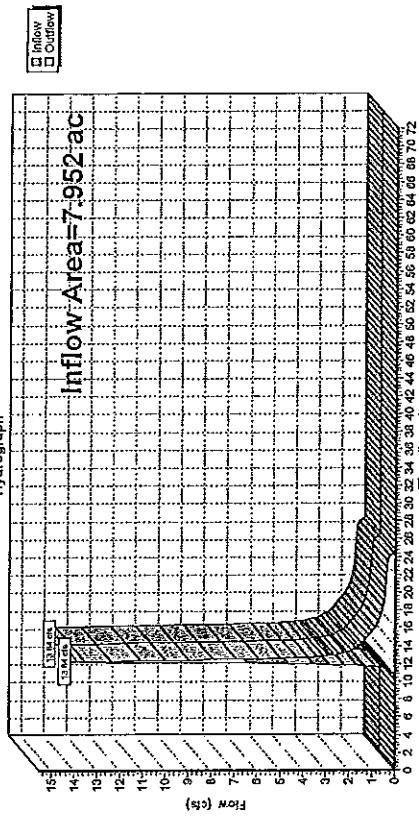
#### Summary for Reach IP#4: PROP. LINE

Inflow Area = 7.952 ac, 4.43% Impervious, Inflow Depth = 2.07" for 25YR REV event  
 Inflow = 13.84 cfs @ 12.22 hrs, Volume= 1,370 af, Atten= 0%, Lag= 0.0 min  
 Outflow = 13.84 cfs @ 12.22 hrs, Volume= 1,370 af, Atten= 76%, Lag= 42.7 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

#### Reach IP#4: PROP. LINE

Hydrograph



#### Summary for Pond 5PND: BASIN#1

Inflow Area = 8.791 ac, 34.42% Impervious, Inflow Depth = 3.27" for 25YR REV event  
 Inflow = 20,933 cfs @ 12.34 hrs, Volume= 2,397 af  
 Outflow = 4,98 cfs @ 13.05 hrs, Volume= 2,397 af, Atten= 76%, Lag= 42.7 min  
 Discarded = 0.31 cfs @ 13.05 hrs, Volume= 0.504 af  
 Primary = 4,87 cfs @ 13.05 hrs, Volume= 1,893 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs  
 Peak Elev= 378.43' @ 13.05 hrs Surf.Area= 12,995 sf Storage= 44,354 cf  
 Plug-Flow detention time= 186.1 min calculated for 2.397 af (100% of inflow)  
 Center-of-Mass det. time= 185.7 min (1,032.0 - 846.3)

Volume	Invert	Avail.Storage	Storage Description	Custom Stage Data (Prismatic) Listed below (Recalc)
#1	374.00'	82,639 cf		
Elevation	Surf.Area (sq-ft)	Incr.Store (cubic-feet)	Cum.Store (cubic-feet)	
(feet)				
374.00	7,184	0	0	
376.00	9,666	16,850	16,850	
378.00	12,357	22,023	38,873	
380.00	15,306	27,663	66,536	
381.00	16,900	16,103	82,639	

Device	Routing	Invert	Outlet Devices	
#1	Discarded	374.00'	1,020 in/hr Exfiltration over Surface area	
#2	Primary	375.00'	6.0" Vert. Orifice/Grate C= 0.600	
#3	Primary	375.25'	8.0" Vert. Orifice/Grate C= 0.600	
#4	Primary	378.25'	12.0" Vert. Orifice/Grate C= 0.600	

Discarded OutFlow Max=0.31 cfs @ 13.05 hrs HW=378.43' (Free Discharge)

↓-1=Exfiltration (Exfiltration Controls 0.31 cfs)

Primary OutFlow Max=4.67 cfs @ 13.05 hrs HW=378.43' (Free Discharge)

↓-2=Orifice/Grate (Orifice Controls 1.69 cfs @ 8.59 fps)

↓-3=Orifice/Grate (Orifice Controls 2.84 cfs @ 8.13 fps)

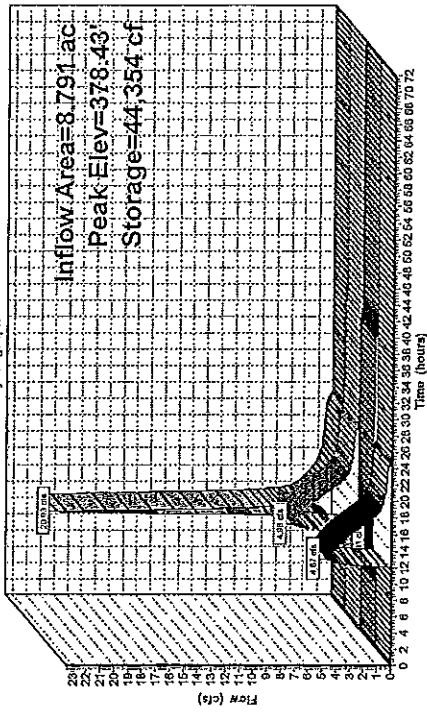
↓-4=Orifice/Grate (Orifice Controls 0.14 cfs @ 1.45 fps).

post development 1-17  
Prepared by {enter your company name here}  
HydroCAD® 10.00-16 sm 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 25YR REV Rainfall=6.22"  
Printed 2/1/2017  
Page 49

### Pond 5PND: BASIN#1

#### Hydrograph



Type III 24-hr 25YR REV Rainfall=6.22"  
Prepared by {enter your company name here}  
HydroCAD® 10.00-16 sm 01433 © 2015 HydroCAD Software Solutions LLC

post development 1-17  
Prepared by {enter your company name here}  
HydroCAD® 10.00-16 sm 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 25YR REV Rainfall=6.22"  
Printed 2/1/2017  
Page 50

### Summary for Pond 7P: BASIN#2

Inflow Area = 8.582 ac, 13.11% Impervious, Inflow Depth = 2.42" for 25YR REV event  
Inflow = 11.71 cfs @ 12.58 hrs, Volume= 1,732 ac  
Outflow = 6.35 cfs @ 13.05 hrs, Volume= 1,732 ac, Atten= 46%, Lag= 28.3 min  
Discarded = 0.18 cfs @ 13.05 hrs, Volume= 0.203 ac  
Primary = 6.17 cfs @ 13.05 hrs, Volume= 1,529 ac

Routing by Stor-Inv method, Time Span= 0.00-72.00 hrs, dI= 0.05 hrs  
Peak Elev= 372.90 @ 13.05 hrs Surf.Area= 7,708 sf Storage= 19,187 cf

Plug-Flow detention time= 83.0 min calculated for 1.732 ac (100% of inflow)  
Center-of-Mass det. time= 82.7 min (964.5 - 881.8)

Volume	Invert	Avail.Storage	Storage Description	Custom Stage Data (Prismatic) Listed below (Recalc)
#1	369.00'	38,325 cf		

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
369.00	1,600	0	0
370.00	3,750	2,675	2,675
372.00	6,400	10,150	12,825
374.00	9,300	15,700	28,525
375.00	10,300	9,800	38,325

#### Device Routing

#### Invert

#### Outlet Devices

#1 Discarded 369.00' 1.020 inhr Exfiltration over Surface area  
#2 Primary 370.00' 3.0" Vert. Orifice/Grate C= 0.600  
#3 Primary 370.75' 10.0" Vert. Orifice/Grate C= 0.600  
#4 Primary 372.85' 12.0" Vert. Orifice/Grate C= 0.600

Discarded OutFlow Max=0.18 cfs @ 13.05 hrs HW=372.90' (Free Discharge)

Primary OutFlow Max=6.16 cfs @ 13.05 hrs HW=372.90' (Free Discharge)

1=Exfiltration (Exfiltration Controls 0.18 cfs)

2=Orifice/Grate (Orifice Controls 2.69 cfs @ 7.72 ps)

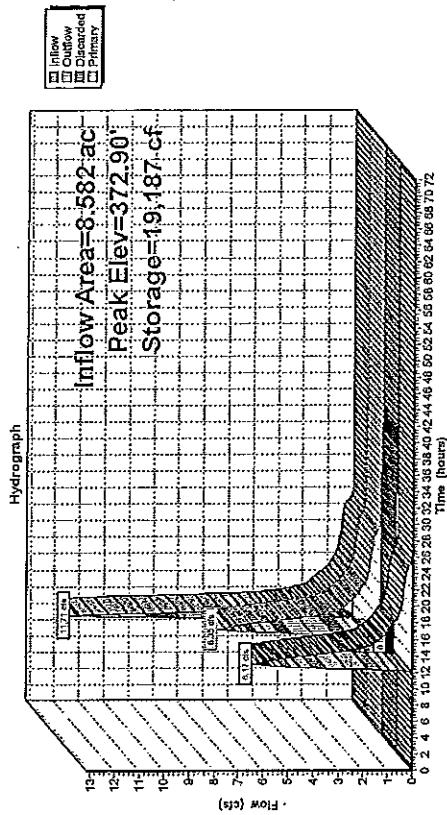
3=Orifice/Grate (Orifice Controls 3.46 cfs @ 6.34 ps)

4=Orifice/Grate (Orifice Controls 0.01 cfs @ 0.77 ps)

**post development 1-17**  
 Prepared by {enter your company name here}  
 HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC

**Type III 24-hr 25YR REV Rainfall=6.22"**  
 Printed 2/1/2017  
 Page 51

#### Pond 7P: BASIN#2



**post developmentmen 1-17**  
 Prepared by {enter your company name here}  
 HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC

**Type III 24-hr 50YR REV Rainfall=7.42"**  
 Printed 2/1/2017  
 Page 52

**Type III 24-hr 50YR REV Rainfall=7.42"**  
 Prepared by {enter your company name here}  
 HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC

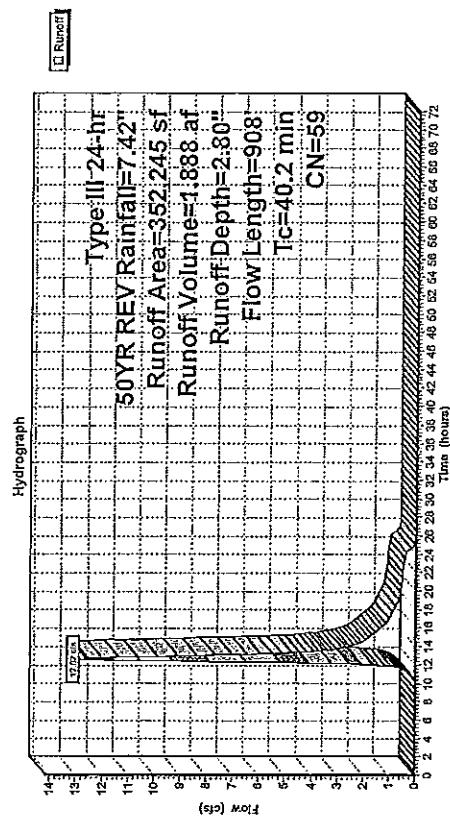
#### Summary for Subcatchment 1P: DA#1P

Runoff	=	12.82 cfs @ 12.59 hrs, Volume=	1.888 ac, Depth= 2.80"		
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs					
Type III 24-hr 50YR REV Rainfall=7.42"					
Area (sf)	CN	Description			
24.004	98	Paved parking & roofs			
80,175	61	>75% Grass cover, Good, HSG B			
248.066	55	Woods, Good, HSG B			
352.245	59	Weighted Average			
328.241		93.19% Pervious Area			
24,004		6.81% Impervious Area			
Tc	Length (feet)	Slope (in/in)	Velocity (ft/sec)	Capacity (cfs)	Description
28.3	50	0.0100	0.03	Sheet Flow, TRAVEL PATH A TO B	
7.2	409	0.0360	0.95	Woods; Dense underbrush, n= 0.800 P=3.20"	
1.3	140	0.0150	1.84	Shallow Concentrated Flow, TRAVEL PATH B TO C Woodland Kv= 5.0 tps	
0.3	100	0.0150	6.02	Shallow Concentrated Flow, TRAVEL PATH C TO D Grassed Waterway Kv= 15.0 tps	
0.8	89	0.0150	1.84	Pipe Channel, TRAVEL PATH D TO E 12.0" Round Area= 0.8 of Perim= 3.1' r= 0.25' r= 0.012 Concrete pipe, finished	
2.3	120	0.0300	0.87	Shallow Concentrated Flow, TRAVEL PATH E TO F Grassed Waterway Kv= 15.0 tps	
				Shallow Concentrated Flow, TRAVEL PATH F TO G Woodland Kv= 5.0 tps	
40.2	908	Total			

post development 1-17  
Prepared by {enter your company name here}  
HydroCAD® 10.00-16 s/n c1433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 50YR REV Rainfall=7.42"  
Printed 2/1/2017  
Page 53

### Subcatchment 1P: DA#1P



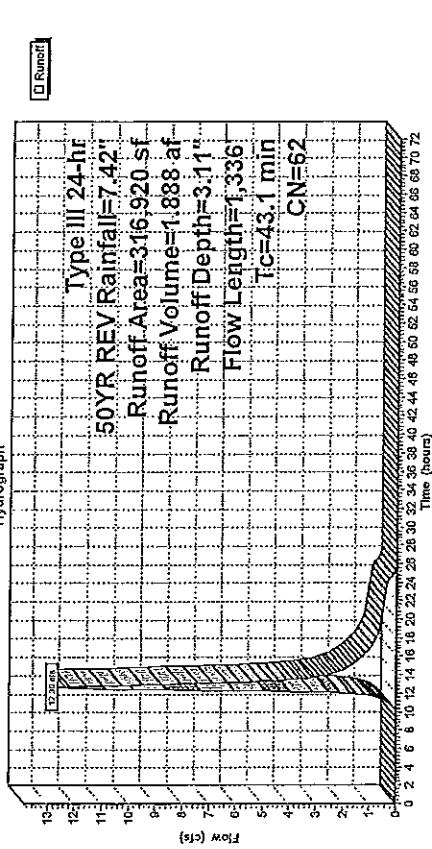
### Summary for Subcatchment 2P: DA#2P

Runoff = 12.36 cfs @ 12.62 hrs, Volume= 1,888.00 af, Depth= 3.11"  
Type III 24-hr 50YR REV Rainfall=7.42"

Area (sf)	CN	Description			
23,199	98	Paved parking & roofs			
127,802	61	>75% Grass cover, Good, HSG B			
165,919	58	Woods/grass comb., Good, HSG B			
316,920	62	Weighted Average			
293,721		92.68% Pervious Area			
23,199		7.32% Impervious Area			
Tc	Length	Slope	Velocity	Capacity	Description
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	
28.3	50	0.0100	0.03		Sheet Flow, TRAVEL PATH A TO B
					Woods: Dense underbrush n= 0.800 P2= 3.20"
					Shallow Concentrated Flow, TRAVEL PATH B TO C
					Woodland Kv= 5.0 fpm
					Shallow Concentrated Flow, TRAVEL PATH C TO D
					Unpaved Kv= 16.1 fpm
					Shallow Concentrated Flow, TRAVEL PATH D TO E
					Woodland Kv= 5.0 fpm

43.1 1,336 Total

### Subcatchment 2P: DA#2P



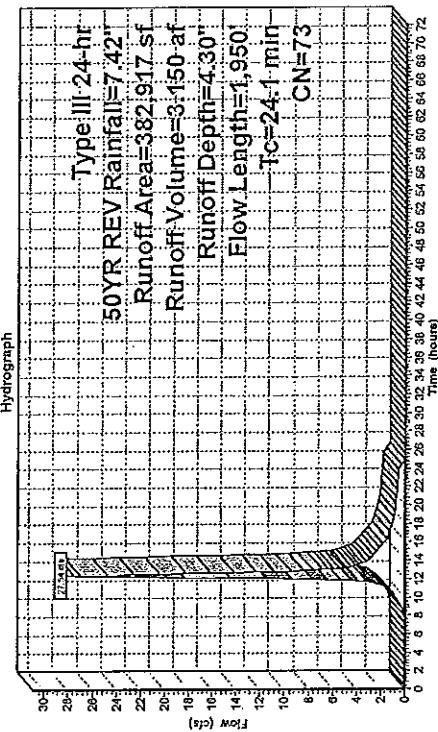
**post development 1-17**  
 Prepared by [enter your company name here]  
 HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 50YR REV Rainfall=7.42"  
 Printed 2/12/2017  
 Page 55

#### Subcatchment 3P: DA#3P

Area (sf)	CN	Description			
131,794	98	Paved parking & roofs			
182,960	61	>75% Grass cover, Good, HSG B			
68,163	55	Woods, Good, HSG B			
382,917	73	Weighted Average			
25,123		65.58% Pervious Area			
131,794		34.42% Impervious Area			
Tc	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.3	50	0.0400	0.05	Sheet Flow, TRAVEL PATH A TO B	
				Woods: Dense underbrush n=0.800	
0.8	200	0.0600	3.94	P=2-3.20"	
				Shallow Concentrated Flow, TRAVEL PATH B TO C	
7.0	1,700	0.0400	4.06	Unpaved Kv= 16.1 fps	
				Shallow Concentrated Flow, TRAVEL PATH C TO D	
24.1	1,950	Total		Paved Kv= 20.3 fps	

#### Subcatchment 3P: DA#3P



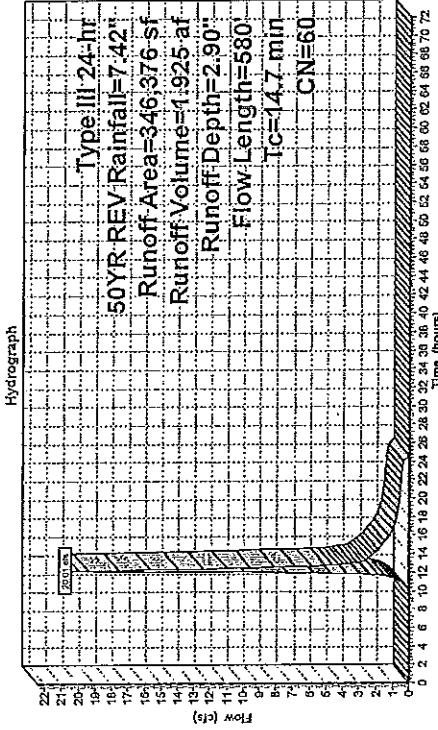
**post development 1-17**  
 Prepared by [enter your company name here]  
 HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 50YR REV Rainfall=7.42"  
 Printed 2/1/2017  
 Page 55

#### Summary for Subcatchment 4P: DA#4P

Runoff	Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs	Runoff = 20.01 cfs @ 12.21 hrs, Volume= 1,925 af, Depth= 2.90"
	Type III 24-hr 50YR REV Rainfall=7.42"	Type III 24-hr 50YR REV Rainfall=7.42"

#### Summary for Subcatchment 4P: DA#4P



post development 1-17  
 Prepared by {enter your company name here}  
 HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC

Type III/24-hr 50YR REV Rainfall=7.42"  
 Printed 2/7/2017  
 Page 57

### Summary for Subcatchment 5P: DA#5P

$$\text{Runoff} = 24.28 \text{ cfs} @ 12.78 \text{ hrs, Volume=} 4,302 \text{ af, Depth=} 2.70"$$

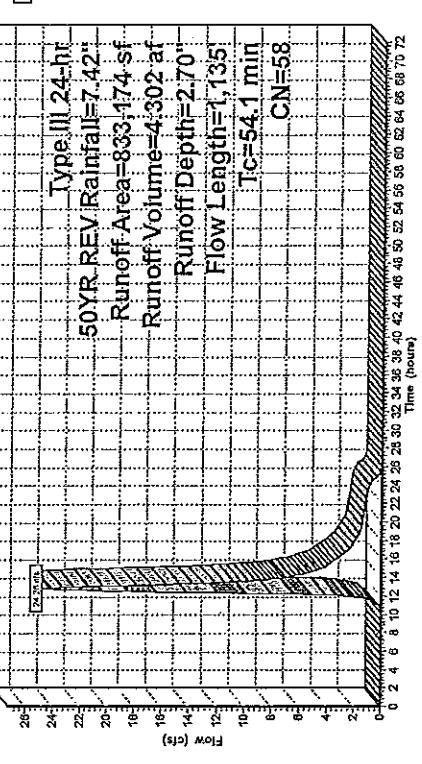
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 50YR REV Rainfall=7.42"

Area (sf)	CN	Description
34,219	98	Paved parking, HSG A
153,139	61	>75% Grass cover, Good, HSG B
645,816	55	Woods, Good, HSG B
833,174	58	Weighted Average
798,955	95.89%	Pervious Area
34,219	4.11%	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
21.5	50	0.0200	0.04	Sheet Flow, TRAVEL PATH A TO B	
				Woods: Dense underbrush n= 0.800	
				P2= 3.20"	
31.2	935	0.0100	0.50	Shallow Concentrated Flow, TRAVEL PATH B TO C	
				Woodland Kv= 5.0 fips	
1.4	150	0.0300	1.73	Shallow Concentrated Flow, TRAVEL PATH C TO D	
				Nearly Bare & Untilled Kv= 10.0 fips	
54.1	1,135	Total			

### Subcatchment 5P: DA#5P

Hydrograph



post development 1-17  
 Prepared by {enter your company name here}  
 HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC

Type III/24-hr 50YR REV Rainfall=7.42"  
 Printed 2/1/2017  
 Page 58

### Summary for Subcatchment 6S: 6P

$$\text{Runoff} = 16.34 \text{ cfs} @ 12.57 \text{ hrs, Volume=} 2,377 \text{ af, Depth=} 3.32"$$

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 50YR REV Rainfall=7.42"

Area (sf)	CN	Description
49,012	98	Water Surface, HSG B
206,232	61	>75% Grass cover, Good, HSG B
118,543	55	Woods, Good, HSG B
373,817	64	Weighted Average
324,805	86.89%	Pervious Area
49,012	13.11%	Impervious Area

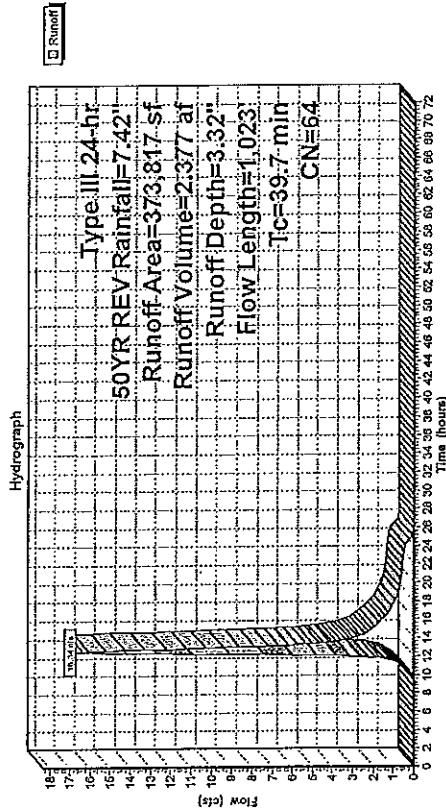
  

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.3	50	0.0300	0.05	Sheet Flow, TRAVEL PATH A TO B	
				Woods: Dense underbrush n= 0.800	
				P2= 3.20"	
1.6	135	0.0800	1.41	Shallow Concentrated Flow, TRAVEL PATH B TO C	
				Woodland Kv= 5.0 fips	
19.4	555	0.0330	0.48	Trap/Vee/Rect Channel Flow, TRAVEL C TO D	
				Bot/W=2.0' D=1.00' Z= 2.0' Top/W=6.00'	
0.4	283	0.0500	11.39	Pipe Channel TRAVEL PATH D TO E	
				12.0' Round Area= 0.8 sf Perim= 3.1' i= 0.25'	
39.7	1,023	Total		n= 0.011 Concrete pipe, finished	

post development 1-17  
Prepared by [enter your company name here]  
HydroCAD® 10.00-16 sn 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 50YR REV Rainfall=7.42"  
Printed 2/1/2017  
Page 59

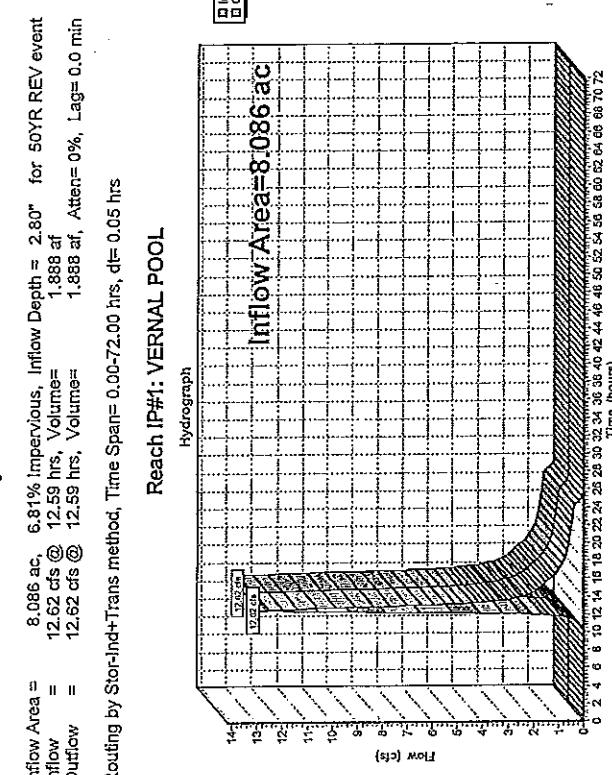
### Subcatchment 6S: 6P



post development 1-17  
Prepared by [enter your company name here]  
HydroCAD® 10.00-16 sn 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 50YR REV Rainfall=7.42"  
Printed 2/1/2017  
Page 59

### Summary for Reach IP#1: VERNAL POOL

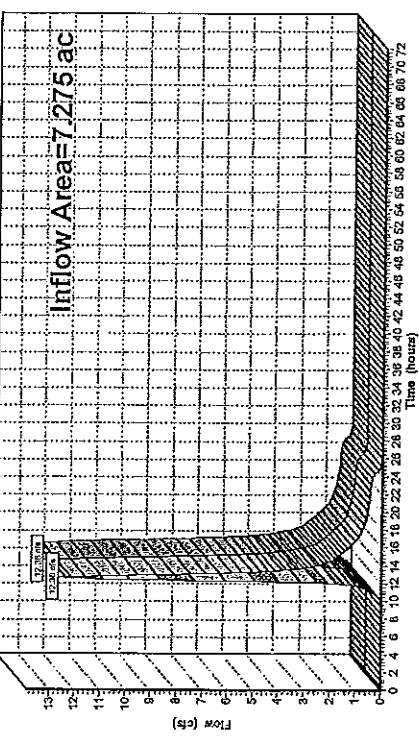


### Summary for Reach IP#2: PROP LINE

Inflow Area = 7.275 ac, 7.32% Impervious, Inflow Depth = 3.11" for 50YR REV event  
Inflow = 12.36 cfs @ 12.62 hrs, Volume= 1.888 af  
Outflow = 12.36 cfs @ 12.62 hrs, Volume= 1.888 af, Atten= 0%, Lag= 0.0 min  
Routing by StoI-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

### Reach IP#2: PROP LINE

Hydrograph

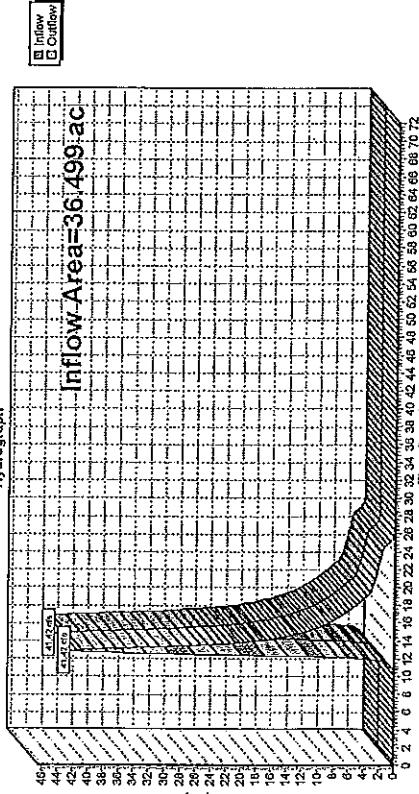


### Summary for Reach IP#3: WETLANDS

Inflow Area = 36.499 ac, 13.52% Impervious, Inflow Depth = 2.99" for 50YR REV event  
Inflow = 41.42 cfs @ 12.83 hrs, Volume= 9.080 af  
Outflow = 41.42 cfs @ 12.83 hrs, Volume= 9.080 af, Atten= 0%, Lag= 0.0 min  
Routing by StoI-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

### Reach IP#3: WETLANDS

Hydrograph



**post development 1-17**  
 Prepared by {enter your company name here}  
 HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC

**Type III 24-hr 50YR REV Rainfall=7.42"**  
 Printed 2/1/2017  
 Page 63

**post development 1-17**  
 Prepared by {enter your company name here}  
 HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC

**Type III 24-hr 50YR REV Rainfall=7.42"**  
 Printed 2/1/2017  
 Page 64

#### Summary for Reach IP#4: PROP. LINE

Inflow Area = 7.952 ac, 4.43% Impervious, Inflow Depth = 2.90" for 50YR REV event  
 Inflow = 20.01 cfs @ 12.21 hrs, Volume= 1.925 af  
 Outflow = 20.01 cfs @ 12.21 hrs, Volume= 1.925 af, Attenu=0%, Lag= 0.0 min  
 Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

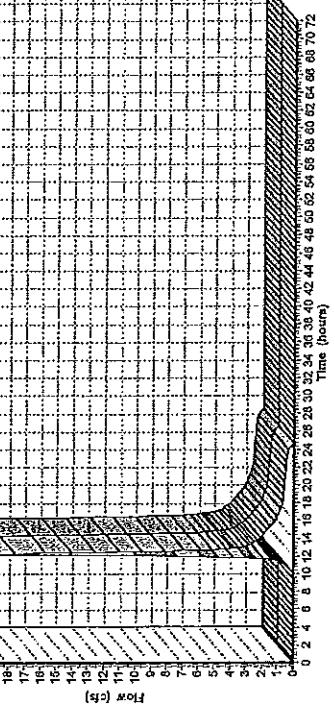
#### Reach IP#4: PROP. LINE

Hydrograph



**Inflow Area=7.952 ac**

Hydrograph



**post development 1-17**  
 Prepared by {enter your company name here}  
 HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC

**Type III 24-hr 50YR REV Rainfall=7.42"**  
 Printed 2/1/2017  
 Page 64

#### Summary for Pond 5PND: BASIN#1

Inflow Area = 8.791 ac, 34.42% Impervious, Inflow Depth = 4.30" for 50YR REV event  
 Inflow = 27.54 cfs @ 12.33 hrs, Volume= 3.150 af  
 Outflow = 8.45 cfs @ 12.90 hrs, Volume= 3.150 af, Attenu= 65%, Lag= 34.0 min  
 Discarded = 0.34 cfs @ 12.90 hrs, Volume= 0.532 af  
 Primary = 8.11 cfs @ 12.90 hrs, Volume= 2.618 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs  
 Peak Elevation= 379.35' @ 12.90 hrs Surf.Area= 14.348 sf Storage= 56.915 cf

Plug-Flow detention time= 166.7 min calculated for 3.148 af (100% of inflow)  
 Center-of-Mass det. time= 167.3 min (1,005.7 - 838.4 )

Volume	Invert	Avail.Storage	Storage Description	Custom Stage Data (Prismatic) Listed below (Recalc)
#1	374.00'	82,639 cf		

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
374.00	7,184	0	0
376.00	9,666	16,850	16,850
378.00	12,357	22,023	38,873
380.00	15,306	27,663	66,536
381.00	16,900	16,103	82,639

Device	Routing	Invert	Outlet Devices
#1	Discarded	374.00'	1,020 in/hr Exfiltration over Surface area
#2	Primary	375.00'	6.0" Vert. Orifice/Grate C= 0.600
#3	Primary	375.25'	8.0" Vert. Orifice/Grate C= 0.600
#4	Primary	378.25'	12.0" Vert. Orifice/Grate C= 0.600

Discarded Outflow Max=0.34 cfs @ 12.90 hrs HW=379.35' (Free Discharge)

1=Exfiltration (Exfiltration Controls 0.34 cfs)

Primary Outflow Max=8.11 cfs @ 12.90 hrs HW=379.35' (Free Discharge)

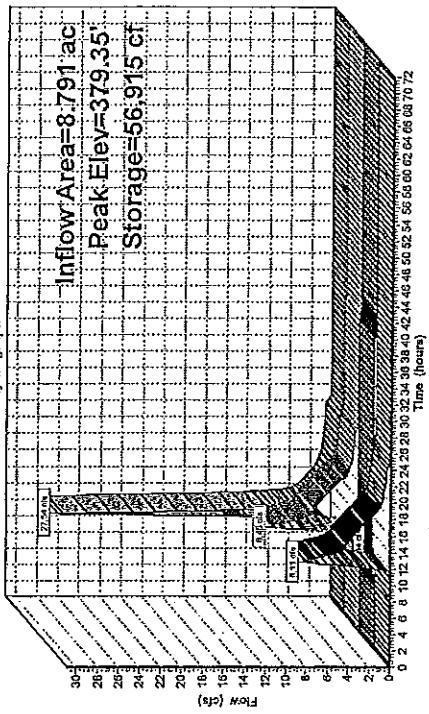
2=Orifice/Grate (Orifice Controls 1.91 cfs @ 9.75 tps)

3=Orifice/Grate (Orifice Controls 3.26 cfs @ 9.35 tps)

4=Orifice/Grate (Orifice Controls 2.93 cfs @ 3.73 tps)

### Pond 5PND: BASIN#1

Hydrograph



post development 1-17  
 Prepared by {enter your company name here}  
 HydroCAD® 10.00-16 sn 01483 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 50 YR REV Rainfall=7.42"  
 Printed 2/1/2017  
 Page 66

### Summary for Pond 7P: BASIN#2

Inflow Area = 8.582 ac, 13.1% Impervious, Inflow Depth = 3.32" for 50YR REV event  
 Inflow = 16.34 cfs @ 12.57 hrs, Volume= 2.377 af  
 Outflow = 9.89 cfs @ 12.97 hrs, Volume= 2.377 af, Atten= 39%, Lag= 24.3 min  
 Discarded = 0.21 cfs @ 12.97 hrs, Volume= 0.217 af  
 Primary = 9.68 cfs @ 12.97 hrs, Volume= 2.161 af

Routing by Star-Grid method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs  
 Peak Elev= 373.74 @ 12.97 hrs Surf.Area= 8,920 sf Storage= 26,136 cf

Plug-Flow detention time= 72.5 min calculated for 2.377 af (100% of inflow)  
 Center-of-Mass det. time= 72.2 min ( 944.6 - 872.5 )

Volume	Invert	Avail Storage	Storage Description	Custom Stage Data (Prismatic) Listed below (Recalc)
#1	369.00'	38,325 cf		
			Cum. Store (cubic-feet)	
			Inc. Store (cubic-feet)	
369.00	1,600	0		
370.00	3,750	2,675		
372.00	6,400	10,150		
374.00	9,300	15,700		
375.00	10,300	9,800		

Device	Routing	Invert	Outlet Devices
#1	Discarded	369.00'	1,020 in/hr Exfiltration over Surface area
#2	Primary	370.00'	8.0" Vert. Orifice/Grate C= 0.600
#3	Primary	370.75'	10.0" Vert. Orifice/Grate C= 0.600
#4	Primary	372.85'	12.0" Vert. Orifice/Grate C= 0.600

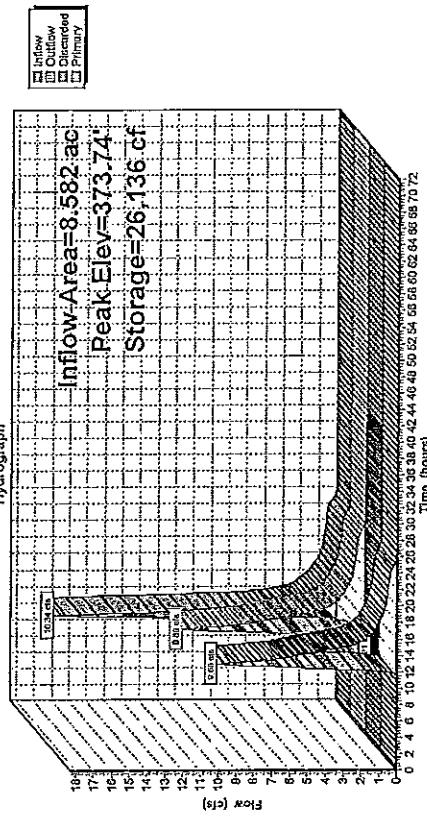
Discarded OutFlow Max=0.21 cfs @ 12.97 hrs HW=373.74' (Free Discharge)  
 ↓=Exfiltration (Exfiltration Controls 0.21 cfs)

Primary OutFlow Max=9.67 cfs @ 12.97 hrs HW=373.74' (Free Discharge)  
 ↓=Orifice/Grate (Orifice Controls 3.10 cfs @ 8.88 fps)  
 ↓=Orifice/Grate (Orifice Controls 4.21 cfs @ 7.72 fps)  
 ↓=Orifice/Grate (Orifice Controls 2.36 cfs @ 3.20 fps)

**Pond 1P: BASIN#2**

Type III 24-hr 50YR REV Rainfall=7.42"  
Prepared by {enter your company name here}  
HydroCAD® 10.00-16 sn 01433 © 2015 HydroCAD Software Solutions LLC  
Printed 2/1/2017  
Page 67

Hydrograph



Type III 24-hr 50YR REV Rainfall=7.42"  
Prepared by {enter your company name here}  
HydroCAD® 10.00-16 sn 01433 © 2015 HydroCAD Software Solutions LLC  
Printed 2/1/2017  
Page 67

**Pond 7P: BASIN#2**

post development 1-17  
Prepared by {enter your company name here}  
HydroCAD® 10.00-16 sn 01433 © 2015 HydroCAD Software Solutions LLC  
Printed 2/1/2017  
Page 67

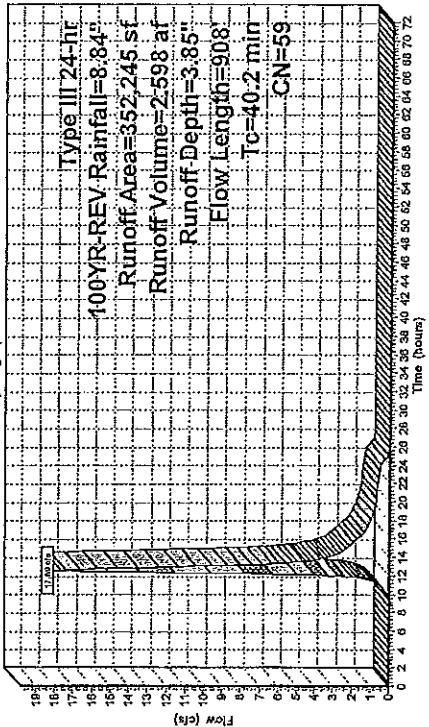
Type III 24-hr 100YR-REV Rainfall=8.84"  
Prepared by {enter your company name here}  
HydroCAD® 10.00-16 sn 01433 © 2015 HydroCAD Software Solutions LLC  
Printed 2/1/2017  
Page 68

**Summary for Subcatchment 1P: DA#1P**

Runoff	=	17.69 cfs @ 12.57 hrs, Volume= 2.598 af, Depth= 3.85"			
Runoff by SCS TR-20 method, UH=SCS Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs					
Type III 24-hr 100YR-REV Rainfall=8.84"					
Area (sf)	CN	Description			
24,004	98	Paved parking & roofs			
80,175	61	>75% Grass cover, Good, HSG B			
248,086	55	Woods, Good, HSG B			
352,245	59	Weighted Average			
328,241	11	93.19% Pervious Area			
24,004	6	6.81% Impervious Area			
Tc (min)	Length (feet)	Slope (feet)	Velocity (ft/second)	Capacity (cfs)	Description
28.3	50	0.0100	0.03	Sheet Flow, TRAVEL PATH A TO B	
				Woods: Dense underbrush n= 0.800 P2= 3.20"	
7.2	409	0.0360	0.95	Shallow Concentrated Flow, TRAVEL PATH B TO C	
				Woodland Kv= 5.0 fps	
1.3	140	0.0550	1.84	Shallow Concentrated Flow, TRAVEL PATH C TO D	
				Grassed Waterway Kv= 15.0 fps	
0.3	100	0.0150	6.02	Pipe Channel, TRAVEL PATH D TO E	
				12.0" Round Area= 0.8 sf Perim= 3.1' f= 0.25'	
0.8	89	0.0150	1.84	n= 0.012 Concrete pipe, finished	
				Shallow Concentrated Flow, TRAVEL PATH E TO F	
2.3	120	0.0300	0.87	Grassed Waterway Kv= 15.0 fps	
				Shallow Concentrated Flow, TRAVEL PATH F TO G	
40.2	908	Total		Woods: Dense underbrush Kv= 5.0 fps	

### Subcatchment 1P: DA#1P

Hydrograph



### Summary for Subcatchment 2P: DA#2P

Runoff = 16.94 cfs @ 12.61 hrs, Volume= 2.558 af, Depth= 4.22"

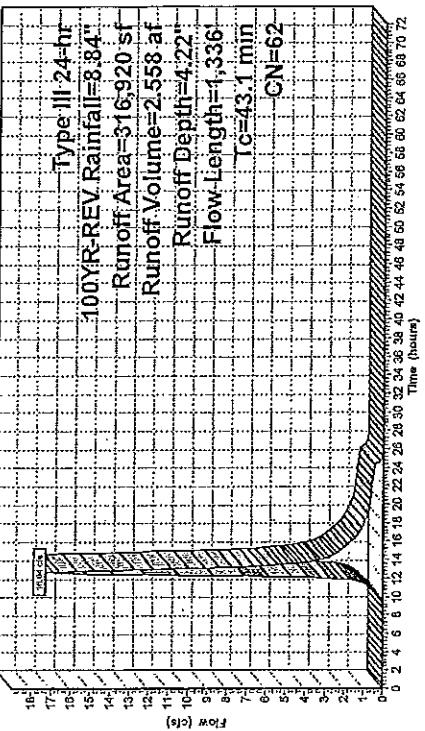
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 100YR-REV Rainfall=8.84"

Area (sf)	CN	Description
23,199	98	Paved parking & roofs
127,802	61	>75% Grass cover, Good, HSG B
165,919	58	Woods/grass comb., Good, HSG B
316,920	62	Weighted Average
283,721	92	92.68% Pervious Area
23,199	7	7.32% Impervious Area

43.1 1,386 Total

### Subcatchment 2P: DA#2P

Hydrograph



Runoff

Type III 24-hr 100YR-REV Rainfall=8.84"  
 Runoff/Area=316.920 sf  
 Runoff/Volume=2.558 af  
 Runoff/Depth=4.22"  
 Flow Length=1.336  
 C=43.1 min  
 CN=62

**post development 1-17**

Prepared by [enter your company name here]  
HydroCAD® 10.0c-16 sn.01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 100YR-REV Rainfall=8.84"  
Printed 2/12/2017  
Page 71

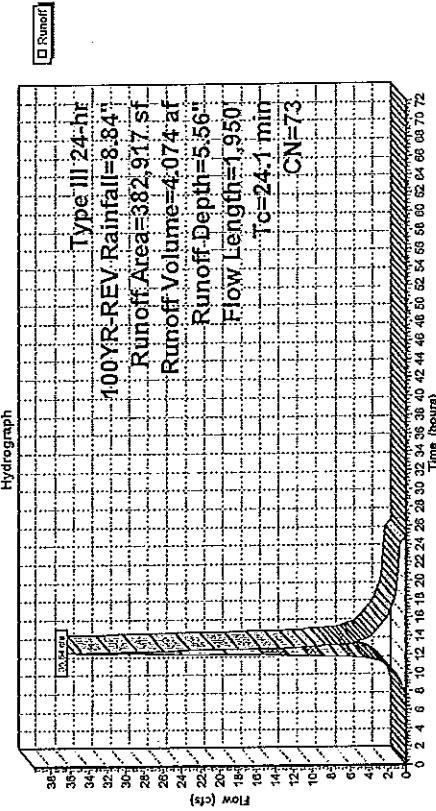
post development 1-17  
Prepared by [enter your company name here];  
HydroCAD® 10.0c-16 sn.01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 100YR-REV Rainfall=8.84"  
Printed 2/12/2017  
Page 72

**Summary for Subcatchment 3P: DA#3P**

Runoff	=	35.54 cfs @ 12.33 hrs. Volume= 4,074 ft <sup>3</sup> , Depth= 5.56"
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs		
Type III 24-hr 100YR-REV Rainfall=8.84"		
Tc	Length	Slope Capacity Description
(min)	(feet)	(ft/sec) (cfs)
16.3	50	0.0400 0.05 Sheet Flow, TRAVEL PATH A TO B Woods: Dense underbrush n= 0.800 P2= 3.20"
0.8	200	0.0600 3.94 Shallow Concentrated Flow, TRAVEL PATH B TO C Unpaved Kv= 16.1 fps
7.0	1,700	0.0400 4.06 Shallow Concentrated Flow, TRAVEL PATH C TO D Paved Kv= 20.3 fps
24.1	1,950	Total

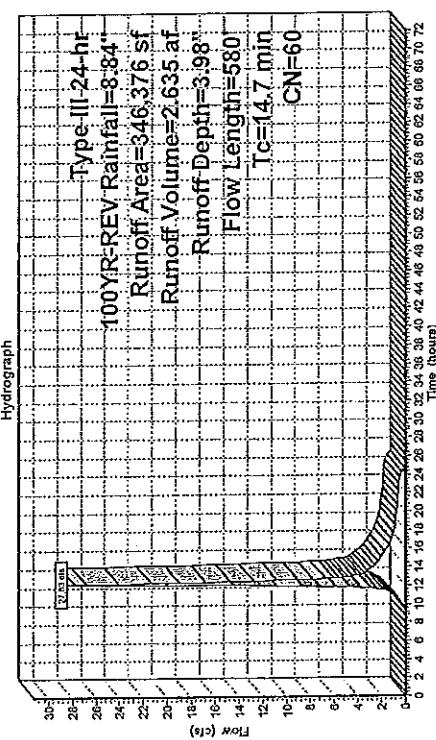
**Subcatchment 3P: DA#3P**



**Summary for Subcatchment 4P: DA#4P**

Runoff	=	27.83 cfs @ 12.21 hrs, Volume= 2,635 af, Depth= 3.98"
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs		
Type III 24-hr 100YR-REV Rainfall=8.84"		
Area (sf)	CN	Description
131,794	98	Paved parking & roofs
182,960	61	>75% Grass cover, Good, HSG B
68,165	58	Woods/Grazing comb, Good, HSG B
382,917	73	Weighted Average
251,123	65	58% Pervious Area
131,794	34	42% Impervious Area
Tc	Length	Slope Velocity Capacity Description
(min)	(feet)	(ft/sec) (cfs)
5.1	50	0.0250 0.16 Sheet Flow, TRAVEL PATH A TO B
0.3	80	0.0750 4.41 Shallow Concentrated Flow, TRAVEL PATH B TO C Unpaved Kv= 16.1 fps
9.3	450	0.0260 0.81 Shallow Concentrated Flow, TRAVEL PATH C TO D Woodland Kv= 5.0 fps
24.1	580	Total

**Subcatchment 4P: DA#4P**



**post development 1-17**  
 Prepared by [enter your company name here]  
 HydroCAD® 10.0-16 sn 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 100YR-REV Rainfall=8.84"  
 Printed 2/1/2017  
 Page 73

### Summary for Subcatchment 5P: DA#5P

$$\text{Runoff} = 34.26 \text{ cfs} @ 12.77 \text{ hrs, Volume=} 5.951 \text{ af, Depth=} 3.73"$$

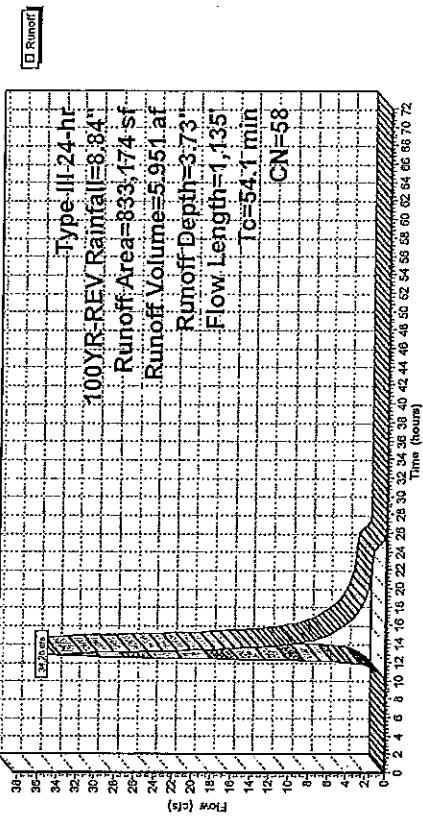
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 100YR-REV Rainfall=8.84"

Area (sf)	CN	Description
34,219	98	Paved parking, HSG A
153,139	61	>75% Grass cover, Good, HSG B
645,816	55	Woods, Good, HSG B
833,174	58	Weighted Average
738,955	95.89%	Pervious Area
34,219	4.11%	Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
21.5	56	0.0200	0.04	Sheet Flow, TRAVEL PATH A TO B	
				Woods: Dense underbrush n= 0.800	P2= 3.20"
				Shallow Concentrated Flow, TRAVEL PATH B TO C	P2= 3.20"
31.2	935	0.0100	0.50	Woodland Kv= 5.0 fps	
1.4	150	0.0300	1.73	Shallow Concentrated Flow, TRAVEL PATH C TO D	
				Nearly Bare & Untilled Kv= 10.0 fps	
54.1	1,135	Total			

### Subcatchment 5P: DA#5P

#### Hydrograph



**post development 1-17**  
 Prepared by [enter your company name here]  
 HydroCAD® 10.0-16 sn 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 100YR-REV Rainfall=8.84"  
 Printed 2/1/2017  
 Page 74

### Summary for Subcatchment 6S: 6P

$$\text{Runoff} = 22.11 \text{ cfs} @ 12.56 \text{ hrs, Volume=} 3.191 \text{ af, Depth=} 4.46"$$

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 100YR-REV Rainfall=8.84"

Area (sf)	CN	Description
49,012	98	Water Surface, HSG B
206,262	61	>75% Grass cover, Good, HSG B
118,543	55	Woods, Good, HSG B
373,817	64	Weighted Average
324,805	86.89%	Pervious Area
49,012	13.11%	Impervious Area

18.3 50 0.0300 0.05

Sheet Flow, TRAVEL PATH A TO B Woods: Dense underbrush n= 0.800 P2= 3.20"

Shallow Concentrated Flow, TRAVEL PATH B TO C Woodland Kv= 5.0 fops

TrapVee/Rect Channel Flow, TRAVEL C TO D Bot.W=2.0' D=1.00' Z= 2.0" Top.W=6.00'

r= 0.4:10 Sheet flow over Bermuda Grass

Pipe Channel, TRAVEL PATH D TO E 12.0' Round Area= 0.8 sf Perim= 3.1' r= 0.25'

n= 0.011 Concrete pipe, finished

Runoff

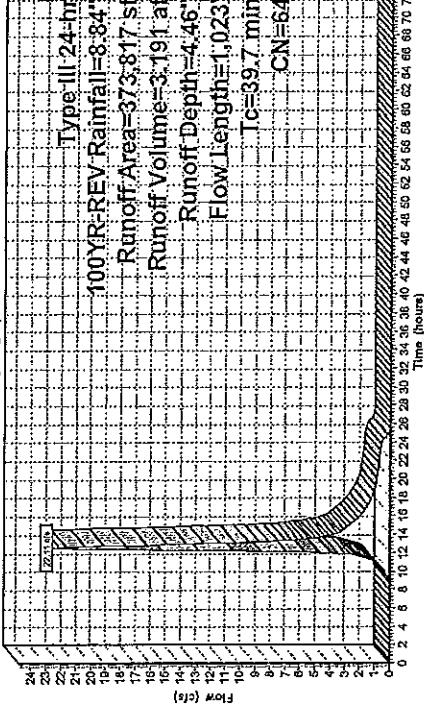
Runoff

post development 1-17  
Prepared by {enter your company name here}  
HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 100YR-REV Rainfall=8.84"  
Printed 2/1/2017  
Page 75

### Subcatchment 6S: 6P

Hydrograph



Type III 24-hr 100YR-REV Rainfall=8.84"  
Prepared by {enter your company name here}  
HydroCAD® 10.00-16 s/n 01433 © 2015 HydroCAD Software Solutions LLC

Printed 2/1/2017  
Page 75

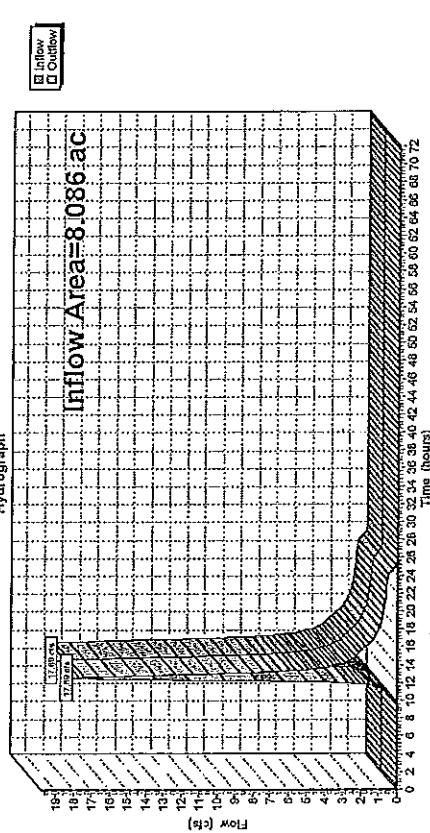
### Summary for Reach IP#: VERNAL POOL

Inflow Area = 8.086 ac, 6.81% Impervious, Inflow Depth = 3.85" for 100YR-REV event  
Inflow = 17.89 cfs @ 12.57 hrs, Volume= 2.598 af  
Outflow = 17.89 cfs @ 12.57 hrs, Volume= 2.598 af, Atten=0%, Lag= 0.0 min

Routing by StoI-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

### Reach IP#1: VERNAL POOL

Hydrograph



Routing by StoI-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

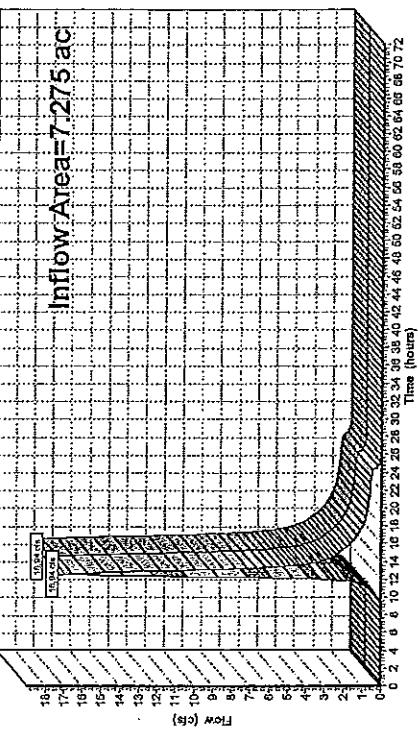
Reach IP#1: VERNAL POOL

### Summary for Reach IP#2: PROP LINE

Inflow Area = 7.275 ac, 7.32% Impervious, Inflow Depth = 4.22" for 100YR-REV event  
Inflow = 16.94 cfs @ 12.61 hrs, Volume= 2.558 af  
Outflow = 16.94 cfs @ 12.61 hrs, Volume= 2.558 af, Attenu= 0%, Lag= 0.0 min  
Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

### Reach IP#2: PROP LINE

Hydrograph

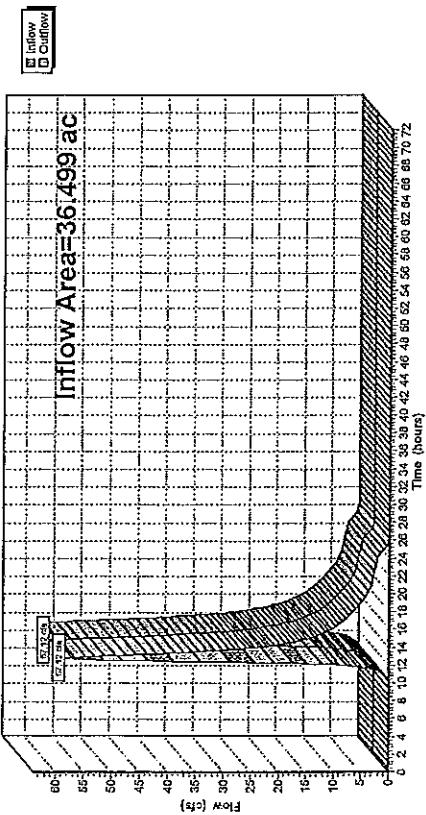


### Summary for Reach IP#3: WETLANDS

Inflow Area = 36.499 ac, 13.52% Impervious, Inflow Depth = 4.08" for 100YR-REV event  
Inflow = 57.12 cfs @ 12.80 hrs, Volume= 12.423 af  
Outflow = 57.12 cfs @ 12.80 hrs, Volume= 12.423 af, Attenu= 0%, Lag= 0.0 min  
Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

### Reach IP#3: WETLANDS

Hydrograph



**post development 1-17**  
 Prepared by {enter your company name here}  
 HydroCAD® 10.00-16 sn:01433 © 2015 HydroCAD Software Solutions LLC

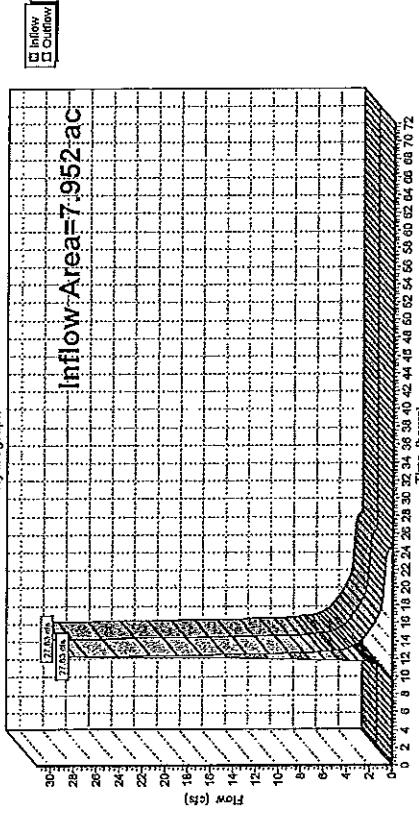
Type III 24-hr 100YR-REV Rainfall=8.84"  
 Printed 2/1/2017  
 Page 79

**Summary for Reach IP#4: PROP. LINE**

Inflow Area = 7.952 ac, 4.43% Impervious, Inflow Depth = 3.98" for 100YR-REV event  
 Inflow = 27.83 cfs @ 12.21 hrs, Volume= 2,635 af, Atten= 0%, Lag= 0.0 min  
 Outflow = 27.83 cfs @ 12.21 hrs, Volume= 2,635 af, Atten= 0%, Lag= 33.2 min  
 Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

**Reach IP#4: PROP. LINE**

**Hydrograph**



**post development 1-17**  
 Prepared by {enter your company name here}  
 HydroCAD® 10.00-16 sn:01433 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 100YR-REV Rainfall=8.84"  
 Printed 2/1/2017  
 Page 80

**Summary for Pond 5PND: BASIN#1**

Inflow Area = 8.791 ac, 34.42% Impervious, Inflow Depth = 5.56" for 100YR-REV event  
 Inflow = 35.54 cfs @ 12.33 hrs, Volume= 4,074 af, Atten= 69%, Lag= 33.2 min  
 Outflow = 11.05 cfs @ 12.88 hrs, Volume= 4,074 af, Atten= 69%, Lag= 33.2 min  
 Discarded = 0.38 cfs @ 12.88 hrs, Volume= 0.561 af, Atten= 33.2 min  
 Primary = 10.67 cfs @ 12.88 hrs, Volume= 3.512 af, Atten= 33.2 min  
 Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs  
 Peak Elev= 330.39' @ 12.88 hrs Surf.Area= 15,827 sf Storage= 72,625 cf

Plug-Flow detention time= 151.9 min calculated for 4,071 af (100% of inflow)  
 Center-of-Mass det. time= 152.5 min (383.6 - 831.1)

Volume	Invert	Avail Storage	Storage Description	Cum.Stage Data [Prismatic] Listed below (Recalc)
#1	374.00'	82,639 cf		
Elevation	Surf.Area (sq-ft)	Invt.Store (cubic-feet)	Cum.Store (cubic-feet)	
(feet)				
374.00	7,184	0	0	
376.00	9,886	16,850	16,850	
378.00	12,387	22,023	38,873	
380.00	15,306	27,863	66,536	
381.00	16,900	16,103	82,639	
Device	Routing	Invert	Outlet Devices	
#1	Discarded	374.00'	1,020 in/hr Exfiltration over Surface area	
#2	Primary	375.00'	6.0" Vert. Orifice/Grate C= 0.600	
#3	Primary	375.25'	8.0" Vert. Orifice/Grate C= 0.600	
#4	Primary	378.25'	12.0" Vert. Orifice/Grate C= 0.600	

Discarded OutFlow Max=0.38 cfs @ 12.88 hrs HW=380.39' (Free Discharge)

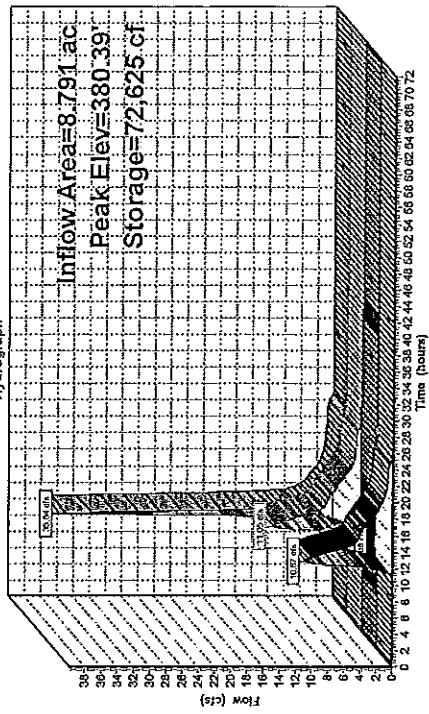
Primary OutFlow Max=10.67 cfs @ 12.88 hrs HW=380.39' (Free Discharge)  
 1-2-Orifice/Grate (Orifice Controls 2.14 cfs @ 10.91 fps)  
 3-Orifice/Grate (Orifice Controls 3.68 cfs @ 10.55 fps)  
 4-Orifice/Grate (Orifice Controls 4.84 cfs @ 6.16 fps)

post development 1-17  
Prepared by [enter your company name here]  
HydroCAD® 10.00-16 s/n 01493 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 100YR-REV Rainfall=8.84"  
Printed 2/1/2017  
Page 81

### Pond 5PND: BASIN#1

Hydrograph



Post development 1-17  
Prepared by [enter your company name here]  
HydroCAD® 10.00-16 s/n 01493 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 100YR-REV Rainfall=8.84"  
Printed 2/1/2017  
Page 82

Prepared by [enter your company name here]  
HydroCAD® 10.00-16 s/n 01493 © 2015 HydroCAD Software Solutions LLC

### Summary for Pond 7P: BASIN#2

Inflow Area = 8.582 ac, 13.11% Impermeable, Inflow Depth = 4.46" for 100YR-REV event  
Inflow = 22.11 cfs @ 12.56 hrs, Volume= 3,191 af  
Outflow = 12.98 cfs @ 12.98 hrs, Volume= 3,191 af, Attenu= 41%, Lag= 25.0 min  
Discarded = 0.24 cfs @ 12.98 hrs, Volume= 0.232 af  
Primary = 12.74 cfs @ 12.98 hrs, Volume= 2,955 af

Routing by Sto-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs  
Peak Elev= 374.86' @ 12.98 hrs Surf.Area= 9,963 sf Storage= 34,912 cf  
Plug-Flow detention time= 64.3 min calculated for 3,189 af (100% of inflow)  
Center-of-Mass det. time= 64.8 min ( 928.7 - 853.9 )

Volume	Invert	Avg.Storage	Custom Stage Data (Prismatic) Listed below (Recalc)
#1	369.00	38,325 cf	
Elevation (feet)	Surf.Area (sq-ft)	Incr.Store (cubic-feet)	Cum.Store (cubic-feet)
369.00	1,600	0	0
370.00	3,750	2,675	2,675
372.00	6,400	10,150	12,825
374.00	9,300	15,700	28,525
375.00	10,300	9,800	38,325

Device Routing Invert Outlet Devices

#1 Discarded 369.00 1.020 In/hr Exfiltration over Surface area  
#2 Primary 370.00 8.0" Vert. Orifice/Grate C= 0.600  
#3 Primary 370.75 10.0" Vert. Orifice/Grate C= 0.600  
#4 Primary 372.85 12.0" Vert. Orifice/Grate C= 0.600

Discarded OutFlow Max=0.24 cfs @ 12.98 hrs HW=374.66' (Free Discharge)

#1=Exfiltration (Exfiltration Controls 0.24 cfs)

Primary OutFlow Max=12.73 cfs @ 12.98 hrs HW=374.86' (Free Discharge)

#2=Orifice/Grate (Orifice Controls 3.50 cfs @ 10.02 fps)

#3=Orifice/Grate (Orifice Controls 4.91 cfs @ 9.00 ips)

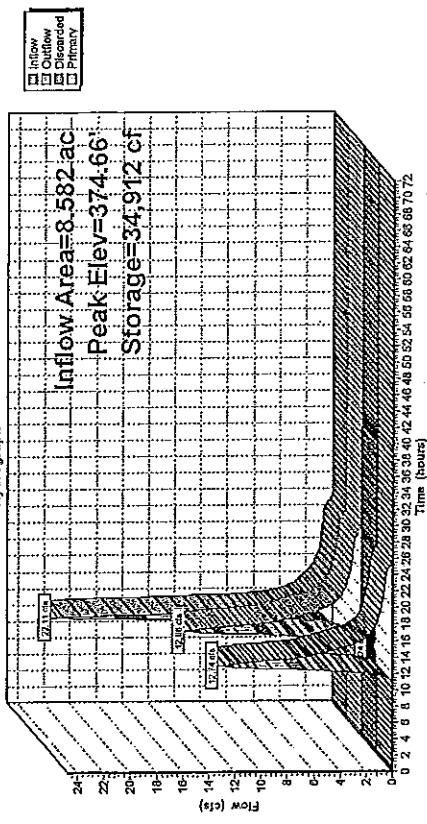
#4=Orifice/Grate (Orifice Controls 4.33 cfs @ 5.51 fps)

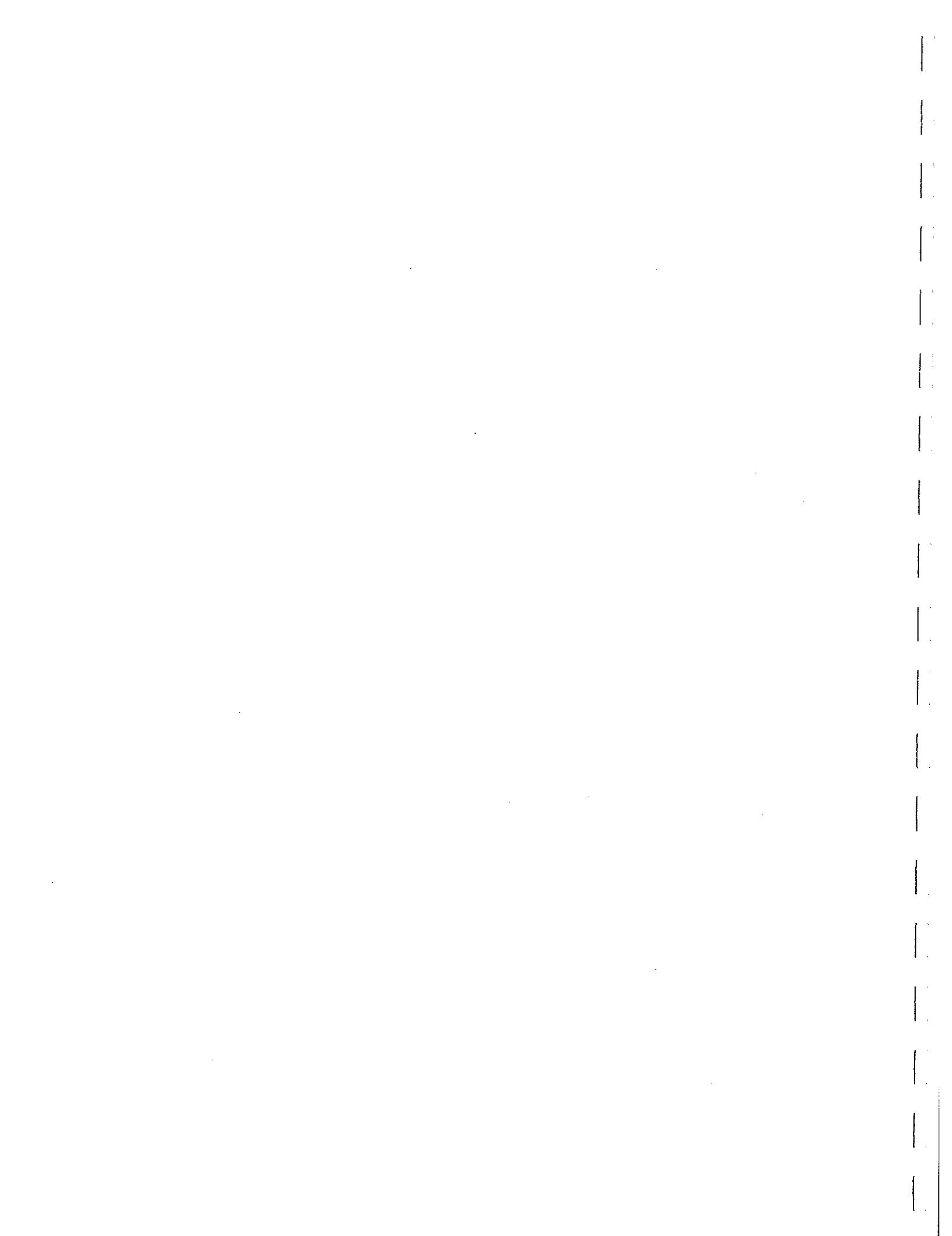
post development 1-17  
Prepared by {enter your company name here}  
HydroCAD® 10.00-16 s/n 01453 © 2015 HydroCAD Software Solutions LLC

Type III 24-hr 100YR-REV Rainfall=8.84"  
Printed 2/12/2017  
Page 83

Pond 7P: BASIN#2

Hydrograph





# **Pipe Calculations**

Job No. W-2658

erriere & Halnon, Inc  
29 Providence Road  
Watertown, MA 01588

DESIGN COMPUTATIONS FOR STORM DRAINS

DESIGN COMPUTATIONS FOR STORM DRAINS

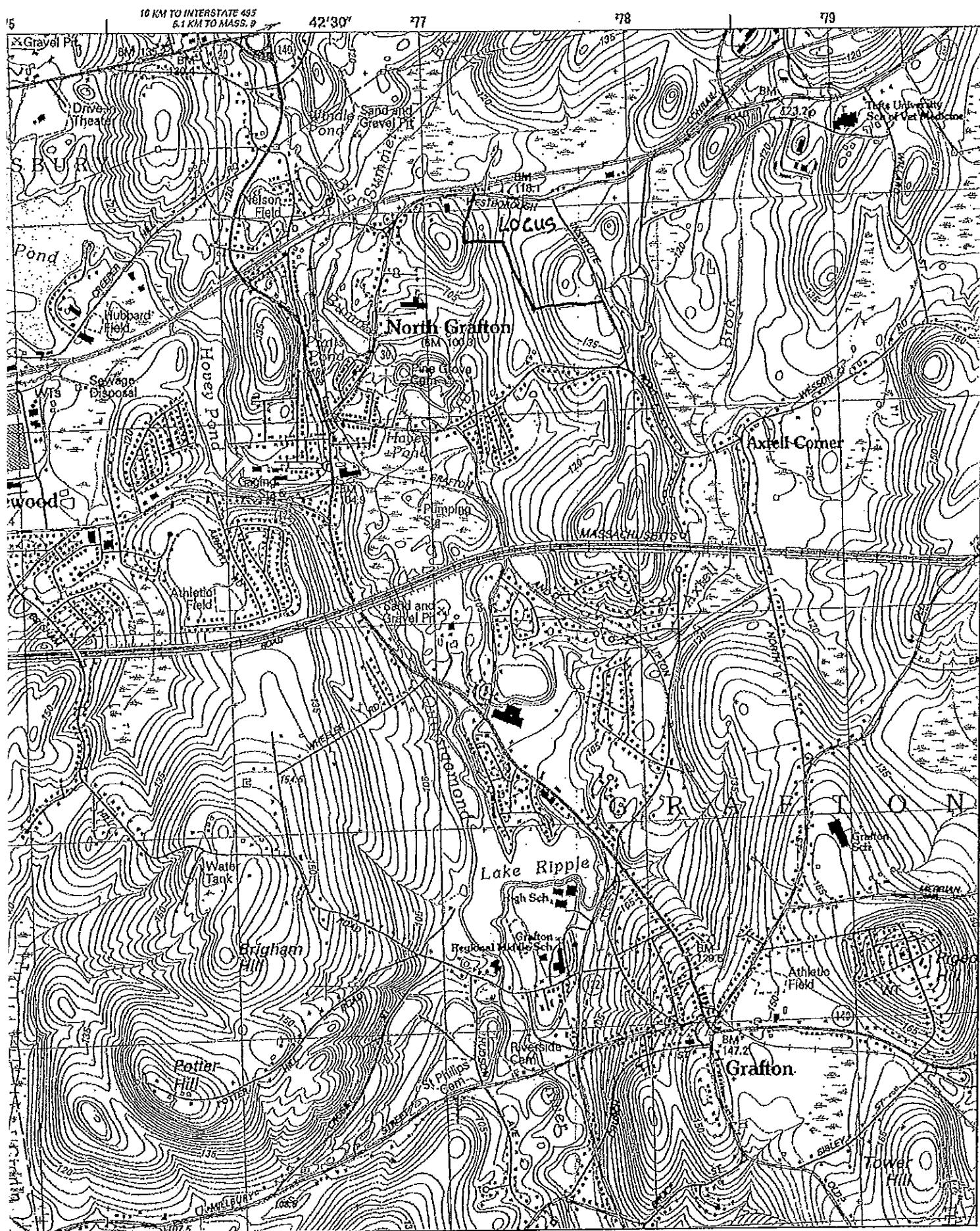
Job No. W-2838  
Guerriere & Fallon, Inc  
1029 Providence Road  
Whitinsville, MA 01588

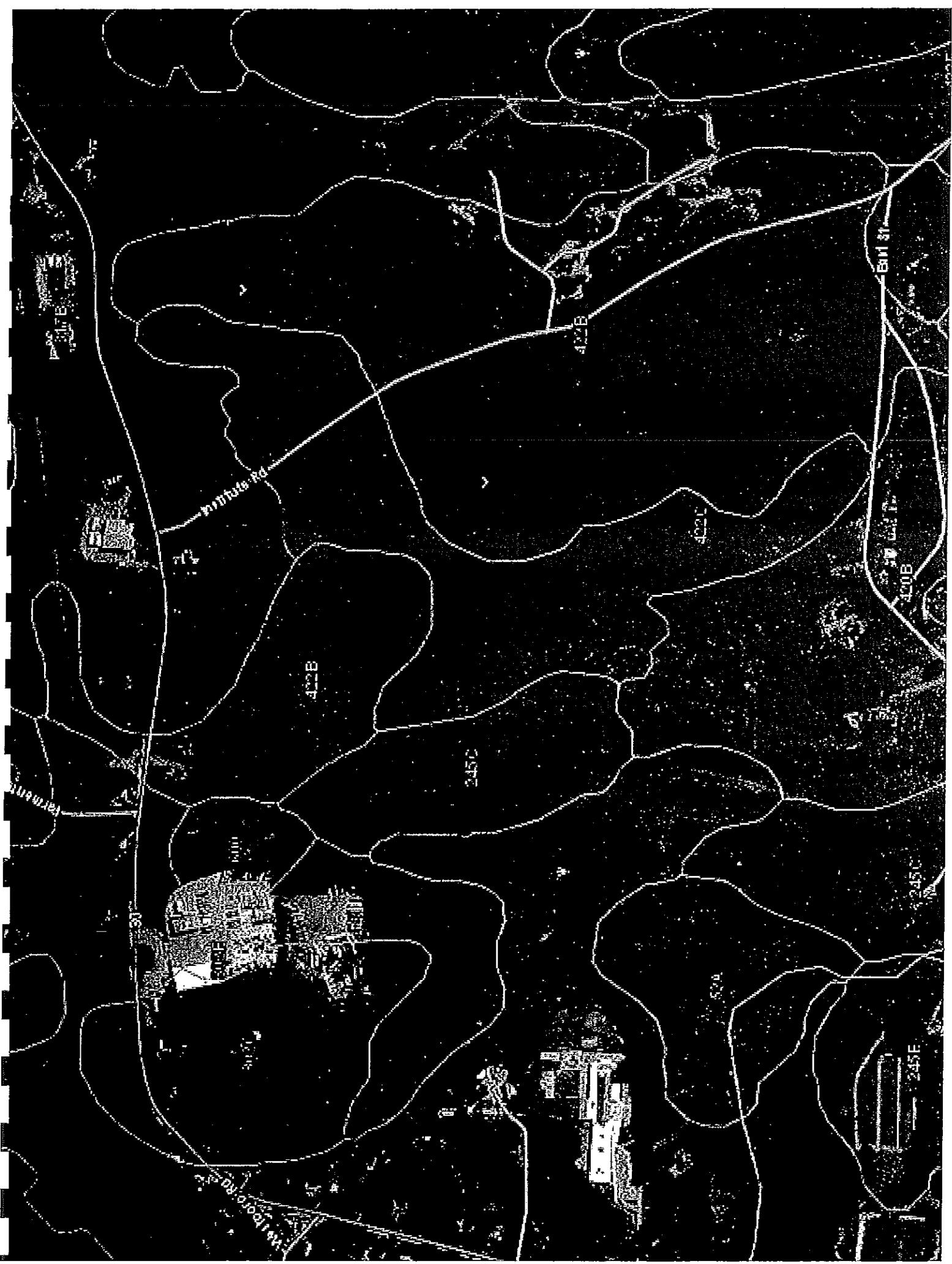
Steam in/hr T=60

Sheet No.: \_\_\_\_\_  
Storm Freq.: \_\_\_\_\_ Date: \_\_\_\_\_  
Revised: \_\_\_\_\_ Computed By: \_\_\_\_\_



## *Soil Information*





Commonwealth of Massachusetts  
City/Town of Grafton  
**Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal**



**C. On-Site Review (continued)**

Deep Observation Hole Number:  
lot#1

Depth (in.)	Soil Horizon Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)		Percent	Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistency (Moist)	Other
			Depth	Color			Gravel	Cobbles & Stones			
0-7	A										
7-24	B					S.L.					
24-84	C		46"			S.L.					

Additional Notes:

---



---



---



---



---



Commonwealth of Massachusetts  
City/Town of Grafton  
**Form 11 - Soil Suitability /**

### C. On-Site Review (continued)

Deep Observation Hole Number:

DTH#2, Sta. 1+25

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color- Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume	Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent					
0-6	A					S.L.				
6-24	B					S.L.				
24-36	C1					S.L.				
36-96	C2					S.L.				

### **Additional Notes:**

Commonwealth of Massachusetts  
 City/Town of Grafton  
**Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal**



**C. On-Site Review (continued)**

Deep Observation Hole Number:  
lot#3, 2+90

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color- Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume	Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent					
0-6	A					S.L.				
6-24	B					S.L.				
24-96	C		60"			S.L.				

Additional Notes:

---



---



---



---



## Commonwealth of Massachusetts City/Town of Grafton

## **Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal**

### C. On-Site Review (continued)

Deep Observation Hole Number:

DTH#4, LOT44 - 40'  
ROAD B

### Additional Notes:

Commonwealth of Massachusetts  
 City/Town of Grafton  
**Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal**



**C. On-Site Review (continued)**

Deep Observation Hole Number:

lot#5, ROAD B 5+00

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color- Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-6	A					S.L.					
6-26	B					S.L.					
26-36	C1					S.L.					
36-92	C2		80"			S.L.					

Additional Notes:



## Commonwealth of Massachusetts City/Town of Grafton

## Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

### C. On-Site Review (continued)

## Deep Observation Hole Number:

DTH#6 RDB & RDC

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color- Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume	Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent					
0-6	A					S.L.				
6-28	B					S.L.				
28-82	C		64"			S.L.				

### Additional Notes:



## Commonwealth of Massachusetts City/Town of Grafton

## Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

### C. On-Site Review (continued)

### Deep Observation Hole Number:

lot#8, ROAD C 3+00

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-6	A					S.L.					
6-18	B					S.L.					
18-52	C1					S.L.					
52-96	C2				64"	S.L.					

Additional Notes:

Commonwealth of Massachusetts  
 City/Town of Grafton  
**Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal**



**C. On-Site Review (continued)**

Deep Observation Hole Number: DTH#7 ROAD C

Depth (in.)	Soil Horizon Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)		Soil Texture (USDA)	Coarse Fragments % by Volume	Cobbles & Stones	Soil Structure	Soil Consistency (Moist)	Other
			Depth	Color						
0-4	A				S.L.					
4-22	B				S.L.					
22-96	C	60"			S.L.					

Additional Notes:

---



---



---



**Commonwealth of Massachusetts  
City/Town of Grafton  
Form 11 - Soil Suitability /**

## Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

### **C. On-Site Review (continued)**

### Deep Observation Hole Number:

Lot#9, ROAD C 5+00

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color Moist (Munsell)			Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume	Soil Structure	Soil Consistence (Moist)	Other
		Depth	Color	Percent	Depth	Color	Percent					
0-6	A							S.L.				
6-18	B							S.L.				
18-52	C1							48"				
52-96	C2									S.L.		

### Additional Notes:



## Commonwealth of Massachusetts City/Town of Grafton

## Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

### C. On-Site Review (continued)

Deep Observation Hole Number:

DTH#10 ROAD C 8+00

### Additional Notes:

Commonwealth of Massachusetts  
 City/Town of Grafton  
**Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal**



**C. On-Site Review (continued)**

Deep Observation Hole Number:

lot#11, ROAD B 10+00

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color- Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistency (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-6	A					S.L.					
6-30	B					S.L.					
30-132	C		9G <sup>n</sup>			S.L.					

Additional Notes:

---



---



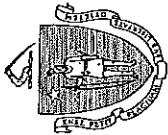
---



---



---



Commonwealth of Massachusetts  
City/Town of Grafton  
**Form 11 - Soil Suitability /**

### C. On-Site Review (continued)

Deep Observation Hole Number:

DTH#12 ROAD B 12+00

### *Additional Notes:*

Commonwealth of Massachusetts  
 City/Town of Grafton  
**Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal**



**C. On-Site Review (continued)**

Deep Observation Hole Number:  
Lot#13, ROAD B 14+00

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color- Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-5	A					S.L.					
5-26	B					S.L.					
26-112	C		84"			L.S.					

Additional Notes:

---



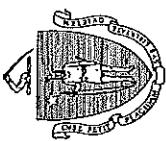
---



---



---



Commonwealth of Massachusetts  
City/Town of Grafton  
**Form 11 - Soil Suitability /**

## Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

### **C. On-Site Review (continued)**

Deep Observation Hole Number:

DTH#14 ROAD A 8+00

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color- Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume	Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent					
0-5	A					S.L.				
65-24	B					S.L.				
24-144	C		112"			L.S.				

### Additional Notes:

Commonwealth of Massachusetts  
 City/Town of Grafton  
**Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal**



**C. On-Site Review (continued)**

Deep Observation Hole Number:

Lot#15, ROAD A 6+00

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color- Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume	Soil Structure	Soil Consistency (Moist)	Other
			Depth	Color	Percent					
0-9	A					S.L.				
9-29	B					S.L.				
29-120	C		102"			L.S.				

Additional Notes:

---



---



---



---



---



Commonwealth of Massachusetts  
City/Town of Grafton  
**Form 11 - Soil Suitability /**

## Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

### C. On-Site Review (continued)

### Deep Observation Hole Number:

DTH#16 ROAD A 4+00

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume	Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent					
0-6	A					S.L.				
6-30	B					S.L.				
30-144	C		102"			L.S.				

### Additional Notes:



## **Commonwealth of Massachusetts City/Town of Grafton**

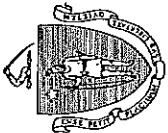
## **Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal**

### C. On-Site Review (continued)

### Deep Observation Hole Number:

lot#17, ROAD A 2+00

### Additional Notes:



## **Commonwealth of Massachusetts City/Town of Grafton**

## Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

### C. On-Site Review (continued)

Deep Observation Hole Number:

DTH#18 ROAD A 1+00

### Additional Notes:

